ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. LVI. No. 3. 220 Broadway, New York, July 19, 1906.

TABLE OF CONTENTS.

LEADING ARTICLES: Page.

Concrete Arch Bridge of the Queensland State Railways, Degilbo, Queensland (illustrated) 57

Regulations Governing the Submission of Water Supply Projects for the Approval of the Prussian Government; Wm. Paul Gerhard..... 57

A Large Railway Freight House and Warehouse at Pittsburg, Pa. (illustrated) 58

The Comparative Advantages of Hard and Soft Steel for Reinforcing Concrete; Daniel B. Luten 62

A Universal Dictionary of Mechanical Drawing, Part XI. Standard Data (illustrated); George H. Follows..... 64

Annual Convention of the American Water-Works Association..... 65

Solid Pier Construction at Baltimore Harbor (illustrated)..... 69

Lumber and Railway Tie Consumption in the United States..... 69

Signals for Protecting Train Movements at Stations and Within Yard Limits; E. Bignell 70

A Proposed Elevated Railway of 1827 (illustrated) 70

Block Signals for Electric Railways (illustrated)..... 70

Fire-Box Steel Failures and Specifications (illustrated); Max H. Wickhorst.... 76

A Report on Chicago Street Railways and Subways (illustrated)..... 79

The Engineering and Technical Societies of the United States and Canada (Addenda) 80

Special Construction Details in a Reinforced Concrete Hardware Store (illustrated) 80

EDITORIAL 73

The Demand for Graduates of Engineering Schools—Conditions Under Which Offers Are Made to These Graduates—Concerning the Demand for Men of Executive Ability—Subways for Electric Haulage and Conduit Systems for the City of Chicago—Government Contract for Armor Plates.

Cement Production in the West..... 73

LETTERS TO THE EDITOR 75

Another Stuck Transit Taken Off; Edwin Squire—Another Plan for Digging the Culebra Cut (illustrated); Chas. L. Marsh—The Effect of the San Francisco Earthquake on a Reinforced Concrete Floor Slab—Correction; F. J. Amweg—Concerning the Reinforcement of Concrete Columns; E. P. Goodrich—Notes and Queries.

ENGINEERING NEWS OF THE WEEK..... 81

PERSONALS 82

ENGINEERING SOCIETIES 82

CONCRETE ARCH BRIDGE ON THE QUEENSLAND STATE RAILWAYS, DEGILBO, QUEENSLAND.

The handsome concrete arch bridge shown in the accompanying engraving was built in 1905 to carry a new branch line extension across the stream known as Deep Creek, about 5 miles west of Degilbo. Described briefly the Gayndah Branch of the Queensland State System leaves the main North Coast Railway, connecting Brisbane and Rockhampton, at Mungar Junction 154 miles north of Brisbane. The branch runs inland and west for 45½ miles to the town of Degilbo, and from there it was extended in 1905, 21 miles further. The branch is constructed as a straight line of 3½ ft. gage, with earth ballast and rails weighing 41¼ lbs. per yard, at a cost of £2,000 per mile.

At the point of crossing Deep Creek has steep rocky banks of columnar basalt of a broken nature overlying a hard, pale blue laminated rock. The presence of this fine foundation rock and the excellence for concrete of the stone, sand and water near at hand determined the use of concrete for the bridge. A comparative estimate for a reinforced concrete arch indicated that its cost would be greater than that of a plain concrete structure. All concrete was a 1-3-6 mixture of 2-in. broken stone.

CONCRETE ARCH BRIDGE OF 80-FT. SPAN ACROSS DEEP CREEK, QUEENSLAND STATE RAILWAYS, AUSTRALIA.

The design and construction of the arch are clearly indicated in the engravings. The main arch has a span of 80 ft. and is 15½ ft. wide; its rise is 28 ft. The curve of the intrados was struck from three centers and is approximately a parabola. Mr. Pagan states that for the loading adopted a more irregular curve than that adopted would, perhaps, have been more correct but it would have been less graceful. The spandrel arches have spans of 13 ft. and rises of 3 ft. They have solid spandrel walls terminating in a coping and are filled above as shown in the accompanying sketch. To provide for the expansion and contraction of the main arch the spandrels are cut with two expansion joints, one at each abutment, as shown in the accompanying sketch, and one on each side of the crown next to the pier of the nearest spandrel arch.

The calculations for the arch were worked out in accordance with the elastic theory as expounded by Professor Cain. A live load of 1,875 long tons per lineal foot of bridge was assumed. This load is nearly 20% in excess of the heaviest engine load in use on the line. A range of temperature of 40° F. was also allowed for. The arch centers were struck when the concrete was one month old; levels taken after striking showed no deflection and no deflection was noticed from traffic.

The total cost of the bridge, which took seven months to complete, was £2,193 per lin. ft., inclusive of plant and supervision. The average cost of all concrete, 860 cu. yds., was 45s. 9d. per cu. yd., cement costing £4 per ton delivered. Rock excavation cost 8s. 8½d. per cu. yd. The wages paid per eight-hour day were: Laborers, 6s. 6d.; carpenters, 8s. 6d. to 10s., and foremen, 10s. 6d. A native cement manufactured by the Commonwealth Portland Co., Ltd., was used. Cubes 9 × 9 × 9 ins. of the concrete used gave after three months a crushing strength of 170 long tons per sq. ft. For the information from which this description has been prepared and for the photographs and drawings accompanying it, we are indebted to Mr. W. Pagan, Chief Engineer, Queensland State Railways, Brisbane, Queensland, Australia, in whose office the bridge was designed, and under whose direction the work was done.

REGULATIONS GOVERNING THE SUBMISSION OF WATER SUPPLY PROJECTS FOR THE APPROVAL OF THE PRUSSIAN GOVERNMENT.

Translated by Wm. Paul Gerhard,* M. Am. Soc. M. E.

[The Prussian Minister for Education and Sanitary Matters published under date of July 5, 1905, the following circular containing Questions Regarding the Requirements for the Approval of Projects for Water Supplies:]

A. PLANS AND SPECIFICATIONS.—(a) Plans of *preliminary* projects are to be submitted in cases where not all the conditions governing the problem are definitely settled or known, or where several modes of obtaining a supply are under consideration, or where the project is very large or complex, requiring large sums for construction, such as the supply for an entire group of villages from one source. In all such cases at least one descriptive report accompanied by an estimate and a general topographical plan showing the outlines of the project is to be submitted.

(b) Plans for *final* projects: these require answers to all the questions given below, also one summary of reliable water gagings, one estimate, one general topographical plan with outlines of the project; one detailed plan with elevations of the entire project, one longitudinal section or profile; detail drawings of all structural work, of pumping stations, also a report of the district sanitary inspector, stating the hardness of the water selected as source of supply, and whether iron contained in the water is precipitated after aeration and subsequent sedimentation. A detailed and complete report is also required on the chemical analysis, with a statement regarding the physical characteristics of the water, reactions, hardness, amount of chlorine and iron, oxygen consumed by organic matter, ammonia, and nitrates (qualitative analysis); also statement whether or not the water acts on lead. Further, bacteriological analyses, if considered necessary by the district sanitary inspector. Submit also any other expert statements, geological reports of the region, etc.

B. PRESENT METHOD OF SUPPLY.—(1) Health conditions and statistics of the district.

(2) How are persons and animals supplied with water? (Domestic wells, public wells and fountains, water courses, ponds, characteristics of the present supply.)

(3) Did cases of epidemic disease (like dysentery, typhoid fever, etc.) occur in the district during the last three years? Enumerate cases for each year.

C. SOURCE OF SUPPLY.—(4) Describe the location of the source of supply; state distance from the village, and elevation of same.

*Consulting Engineer, 33 Union Square, New York City.

(5) Is the source of supply located within the limits of inundation of a river?

(6) What are the surroundings of the source of supply? How is the soil used; is it naturally or artificially manured? Used as pasture? Surface drainage. Describe neighboring houses, or buildings, factories, stables, manure pits, cesspools, cemeteries, sewage irrigation fields, drainage canals, etc.

Submit detailed drawings of surroundings, with profiles and elevations.

(7) From what depth below the surface level is the water to be taken?

State the character of the geological formation from which the water is to be drawn. State the thickness and the sequence of the geological strata, and submit if possible a geological profile. Who is the geological authority for the statements submitted?

(8) Is it contemplated to adopt special measures for the protection of the water intake, or source of supply, from contamination? What are these proposed means?

(9) Is the land on which the source of supply is located the property of the district (or village), or is its purchase contemplated? If so, how much of the land is to be bought?

If a purchase is not contemplated, what are the proposed agreements with the owner of the property regarding the use of the source of supply, regarding prohibiting the manuring of the soil with faecal matter or animal manure?

NOTE.—Very often such stipulations, although entered or mentioned in the lease, are forgotten afterwards, and a regular supervision is difficult to enforce.

(10) Is the source of supply already walled in or encased and protected? (State nature and material of the casing, whether of wood, masonry with cemented or open joints, etc.) In the case of wells state whether well is open or covered. And how? Are there signs of deposition of iron in the reservoir?

(11) When and by whom have the samples of water for the analyses been taken?

D. QUANTITY OR VOLUME OF SUPPLY REQUIRED.—(12) What is the number of inhabitants to be supplied from the works? How many cattle, horses? How many smaller domestic animals to be supplied? Are the cattle at times put in pasture?

(13) What is the prevalent occupation of the population?

(14) Are there any manufacturing and industrial establishments to be supplied (breweries, dyeing establishments, factories)? How much water will these require?

(15) Is the population increasing? If so, state estimated annual percentage of increase?

(16) Is it contemplated to supply buildings by domestic services?

(17) Are public running fountains or public water supply hydrants to be supplied?

(18) What is the estimated maximum daily water consumption?

NOTE.—In rural districts, as a rule, a supply of 50 liters (or 12.5 gals.) per capita per diem is a sufficient allowance; add to this for each horse and each cow 50 liters, and 15 liters for each of the smaller domestic animals. For towns and urban places a daily maximum consumption of 75 to 100 liters per person is sufficient (18.75 to 25 gals.). The provision for the increase in population must be suitably determined by the requirements of each individual case. Where, for special reasons, a deviation from the above figures relating to water consumption is made, these should be specially stated.

E. AVAILABLE AMOUNT OF SUPPLY.—Give a summary of the available water gagings and state how reliable they are.

(19) Who made the measurements or gagings given in the list? How were they made? State dates, temperature of the air and of the water, turbidity and general appearance of the water.

NOTE.—The value of reliable gagings which extend over a greater period of time can not be overestimated. Especially is this true of a supply from springs, for which the gagings do not cost much, and which expenses are in any event less than the risk run of having chosen an insufficient supply, or of having based the water supply project on insufficient data. For this reason, statements of actual gagings are of great value and are always required.

In the case of larger works reliable gagings should be taken once every fortnight. Statements regarding weather conditions preceding the time when gagings are taken should be given.

If, in the case of wells, pumping experiments have been made, it is necessary to give not only the date, time of pumping, amount of depression of the water table, volume pumped, etc., but it should also be stated whether the level of the ground water was permanent during the taking of observations and measurements; also how soon after pumping ceased the normal water level was restored.

A reduction in the extent of the water gagings is only permissible when an available source of supply is sufficient even for future enlargements of the works.

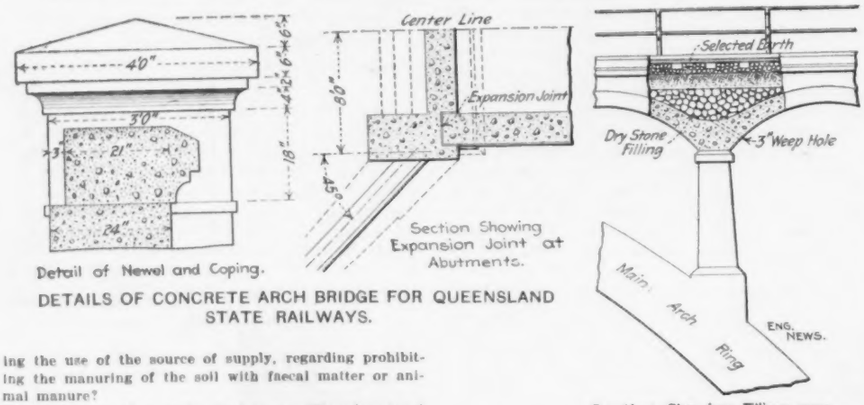
NOTE.—For simple gagings a certified measuring device of at least 10 liters (2½ gals.) contents is sufficient; in order to take the gagings, a dam is thrown across the ditch, and a pipe, about 6 ft. long, or a trough is built into the dam, through which all the water to be measured is made to pass.

(20) Have other sources of supply been investigated, surveyed and gaged?

NOTE.—Such gagings furnish, in many cases, reliable data for future enlargements of the works.

F. TECHNICAL DETAILS.—(21) How will the water be conducted from the source of supply to the district to be supplied? How is the distribution for the district arranged?

Give a short but clear summary of the entire supply project with a statement of distances, levels or elevations, length and diameter of supply mains, location of reservoir.



DETAILS OF CONCRETE ARCH BRIDGE FOR QUEENSLAND STATE RAILWAYS.

(22) What particulars do you wish to give regarding the means for securing the source of supply?

NOTE.—Describe the construction of the supply basin, the protective measures against entrance of contaminated surface or ground water, the protection against dust and dirt, etc.

(23) Where the water must be pumped, state what type of pump or machine for lifting the water is to be used. What type of prime mover will run the pumps? What is the total lift? What schedule for the running of the pumps will be adopted? (How many hours of pumping daily? How much pumping, if any, on Sunday?)

(24) What is the proposed capacity of the supply reservoir?

NOTE.—The reservoir (or the elevated tank) has to serve where pumping is intermittent or where the yield of the supply source is small, as a means of compensation for the differences or variations in the hourly consumption during the day. It is accordingly made of a capacity equal to AT LEAST the *maximum* daily total consumption.

Regarding the additional volume of supply to be stored up for fire extinguishing purposes IN ADDITION to the above quantity see § 38.

(25) Describe the location, construction and equipment of the reservoir; describe supply inlet and outlet; emptying pipe, overflow, float valves, if any; describe the protection against pollution by surface or other water; by dust, dirt, insects, birds, etc.

NOTE.—If the reservoir is constructed with only one chamber, it should be so arranged that it may be cut out for purposes of cleaning or repairs, in cases where the same is located between the source of supply and the place of consumption.

(26) Are means provided or contemplated for the purification of the water? If so, what are they?

NOTE.—Where the character of the water does not render it unnecessary to provide either a filtration plant or a plant for the removal of iron in the water, it is necessary to provide in the project the required head of water (the purification plant being located close to the intake). Likewise, should means be provided for the artificial flushing of all distributing mains.

(27) What are the other means or works required for the collection, storage and distribution of the water? Describe collecting wells, sand chambers, pressure reducing devices, etc.

(28) Of what material are the pipe mains to be?

(29) In determining the diameters of the main supply pipe, has it been taken into consideration that the pipe line must furnish the required volume of supply under the required head of pressure after the pipe lines have become reduced in internal diameter by deposits, incrustrations, etc.?

NOTE.—In determining the size of supply mains the maximum, and not the average, hourly volume required should be taken as a basis for the calculations. Consider also the size required for maximum domestic consumption and that for fire extinction in case of fire (see § 38.)

(30) Is the pipe conduit line provided with air valves and with blowoffs? (Show these in the longitudinal profile and also in the general plan.)

(31) How deep is the proposed covering over the pipes in the trenches?

(32) Is the running of pipe lines through private property secured through a registered deed or easement?

(33) What material is selected or contemplated for the house services? What sizes for the taps and house connections? What sizes for the street mains? What sizes for the risers and other pipe lines within the building?

(34) Are water meters provided? On what system will the furnishing of water to consumers be based?

(35) Has the construction of the works, or any part of them been begun?

G. WATER SUPPLY FOR FIRE PROTECTION.—(36) Is there at present a sufficient volume of water for fire extinguishing purposes? (From special pools, water courses, public pumps, running fountains.)

(37) Are fire hydrants provided? What kind, post hydrants of flush hydrants? What size opening have the hydrants? What size supply pipe?

(38) How much water per second or minute are the hydrants to deliver?

NOTE.—The volume of water available for the supply of a fire hydrant should not, in general, be less than 5 liters or 1¼ gals. per sec. (75 gals. per minute). In order to have a sufficient supply in case of a conflagration, for about three hours' fire-service, it is advisable, in calculating the storage capacity of the main reservoir to add to the amount provided to equalize the variations in the hourly domestic consumption at least 50 cu. ms., or 13,244 gals. for the fire protection.

In the case of smaller rural communities, where houses are scattered, this requirement may be reduced somewhat by placing the supply for a fire hydrant at 2.5 liters per second (150 liters per minute, or 37.5 gals.) and the addition to the volume in the reservoir may be limited to 25 cu. ms., or 6,622 gallons.

In special cases, i. e., if the district or community is very poor, the requirements may be still further reduced, if there are other sources of water supply for fire extinguishing provided, but this must be shown before approval can be secured.

(39) Is it the intention to attach the fire hose directly to the hydrants, or shall these be used only to supply the suction line of the fire engines?

NOTE.—The available water pressure shall in all cases be sufficient to supply the volume of water required by the fire engines, if a direct use of the hydrants can not be secured without a considerably increased expense.

(40) What is the greatest height of the buildings located near those fire hydrants at which the pressure is the lowest?

H. COST OF WORKS.—(41) What is the total estimated cost of the works as planned? What is the per capita expense of the cost of construction (omitting herein the cost of the house connections)? State whether the cost of laying the house services shall be borne by the house owners or by the community-at large?

(42) Are the works to be built by the community, village or district, or else by private enterprise?

I. FURTHER EXPLANATIONS.—Add here all other necessary and available further information, particularly as to the geological formation of the district.

A LARGE RAILWAY FREIGHT HOUSE AND WAREHOUSE AT PITTSBURG, PA.

A warehouse building and freight station on a large scale has recently been established at Pittsburg, Pa., the special feature of which is the provision of numerous independent and private rooms or warehouses for individual firms, which can thus receive, store and ship their merchandise at the one building. In this way a firm may avoid the trouble, expense and delay involved in carting freight from the railway station to the firm's city warehouse, and back again to the same or another station for reshipment. The main building is about 380 × 455 ft., 90 ft. high, with basement and six stories. This building occupies the entire block between Third and Fourth Sts., McKean St., and the Pittsburg & Lake Erie Ry. tracks. On the opposite side of the railway and on the bank of the Monongahela River is the power-house, and eventually a river transfer house will be built adjacent to this for the transfer of freight between railway cars and river steamers or barges. Grain elevators are also to be built. On the opposite (north) side of McKean St. is a four-story building 100 ft. square; this contains the offices and stables and is connected with the main building by a bridge. The entire plant will cover the space of three city blocks, or about five acres, and will have a frontage of 382

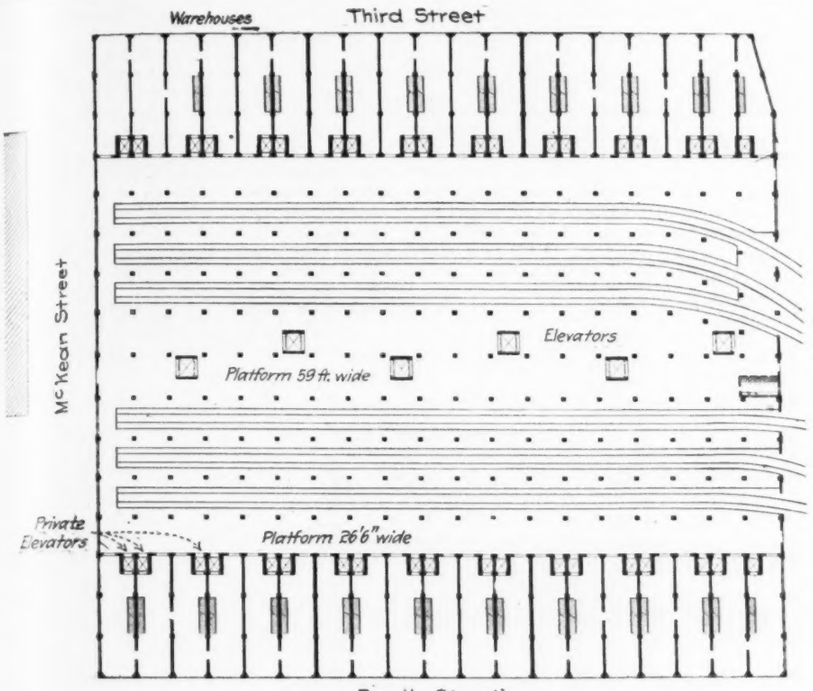


FIG. 1. PLAN OF FIRST FLOOR OF WAREHOUSE; PITTSBURG TERMINAL WAREHOUSE & TRANSFER CO.

Charles A. Bickel, Pittsburg, Pa., Architect and Engineer.

ft. 4 ins. upon the river. This plant is the property of the Pittsburg Terminal Warehouse & Transfer Co. Mr. Chas. Bickel, of Pittsburg, was the architect and engineer, and the construction was mainly done by day labor under his supervision.

The main warehouse building is of steel skeleton construction with brick walls. The floors are of hollow tile construction, forming vaulted arches between the beams, and the columns are encased in brick and concrete. The first floor, Fig. 1, is the freight station, with six tracks; two each for the Wabash Ry., Pennsylvania System and Pittsburg & Lake Erie Ry. The three tracks on each side are separated by 11-ft. platforms, while in the middle is a main platform 59 ft. wide; all the platforms are connected by a transverse platform at the head end of the building. Opening from each side of the freight house, and served by a 26½ ft. platform, is a row of 19 long and narrow compartments forming the warehouses. These compartments are extended to the full height of the building, each having a basement and six upper floors, but in the upper floors they are of greater length (approximately 20 × 155 ft.), extending over the space devoted to the freight station on the first floor, as shown by the plan in Fig. 2. The basements do not extend under the tracks. Each compartment therefore forms a complete private warehouse, with its own 2-ton Otis electric elevator, 8 × 6 ft. The general construction and arrangement are shown in the cross section, Fig. 3.

On the second floor is a central platform, 48 × 380 ft., which is served by six 3-ton Otis electric elevators from the freight house floor below. Here the outgoing freight is collected, ready to be sent down to the train platform. These elevators are enclosed in fire walls, and are referred to later. The third floor is similar except that a roadway 34 ft. wide takes the place of the platform, and is continued at one end by a bridge crossing McKean St. and extending to Carson St. (the site being on sloping ground); at the other end of the roadway a bridge extends to the power plant. On each side of the roadway is a 5½ ft. platform covered by a canopy roof, and here the tenants have their offices and can receive and ship goods by wagons. The upper floors are similar, the two rows of compartments being separated by a 48-ft. light shaft above the level of the roadway. While most of the warehouses are of the dimensions above noted, some of the floors are specially arranged with cold storage rooms, the equipment for which is noted further on. The smaller elevators run from the basement to the top floor, but the large elevators run only from the freight station to the second floor. The tenants may rent one or more of the floors, according to the extent of their business, or they may rent one or more complete sections. Each section forms a complete seven-story warehouse with its own elevator and entirely independent of all the other tenants. Where a tenant has more than one section, the number of doors in the dividing wall will be limited, as noted further on.

The foundations are concrete piles on the system of the Simplex Concrete Piling Co., of Philadelphia. There are about 5,000 of these piles, 30 to 48 ft. long, and these were all put down in 76 working days. Concrete piles were adopted owing to the variation in ground water-level, and also because it was feared that wooden piles would be damaged in driving so as not to afford a full permanent bearing value. The material through which they were sunk was filled ground to a depth of 20 to 25 ft., beneath which was gravel. The assumed bearing load was 30 tons per pile, and a test of four piles loaded with 175 tons of pig iron (43.75 tons per pile) showed a settlement of about ⅜-in. to each pile. Piles exposed in excavating for trenches were found to be perfectly solid, and well bonded to the surrounding material by the roughness of the surface. The piles are cylindrical, 16 ins. diameter, and are composed of a mixture of 1:2½:5. No steel reinforcement is used. They are arranged in groups of 14 to 16, each group being capped by a concrete footing block or pier. In constructing a pile on this system, a steel pipe of the required diameter is driven by an ordinary pile driver, the pipe being fitted with a hinged cast-iron point. When the driving is completed, the pipe is pulled up a little distance and the latch of the point released, allowing it to open out and leave the hole free. Concrete is then filled into the pipe, which is withdrawn as the filling progresses, leaving the concrete in contact with the face of the ground.

The columns are each composed of four Z-bars with a central web plate, while some of the largest columns have also two cover plates, forming a double box section. The columns, with the concrete filling, and the metal guards used on the first and second floors, are shown in Fig. 4. The floor panels are 22 ft. 1½ ins. × 20 ft., with 24-in. 80-lb. I-beams on the longer sides and 18-in. 55-lb. I-beams on the shorter sides. Each panel is subdivided by two 8-in. I-beams cambered 18 ins. for the vaulted floor, and has a 9-in. diagonal I-beam across each corner. The steel columns on the first and second floors are encased in concrete; all other columns are encased in about 4 ins. of brick. The roof framing consists mainly of 15-in. I-beams for the spans of 22 ft. 1½ ins. (18-in. beams in the panel in which the elevators are located), with lines of 10-in. I-beams between them, forming panels about 20 × 5½ ft. The steel work was built by the Jones & Laughlin Steel

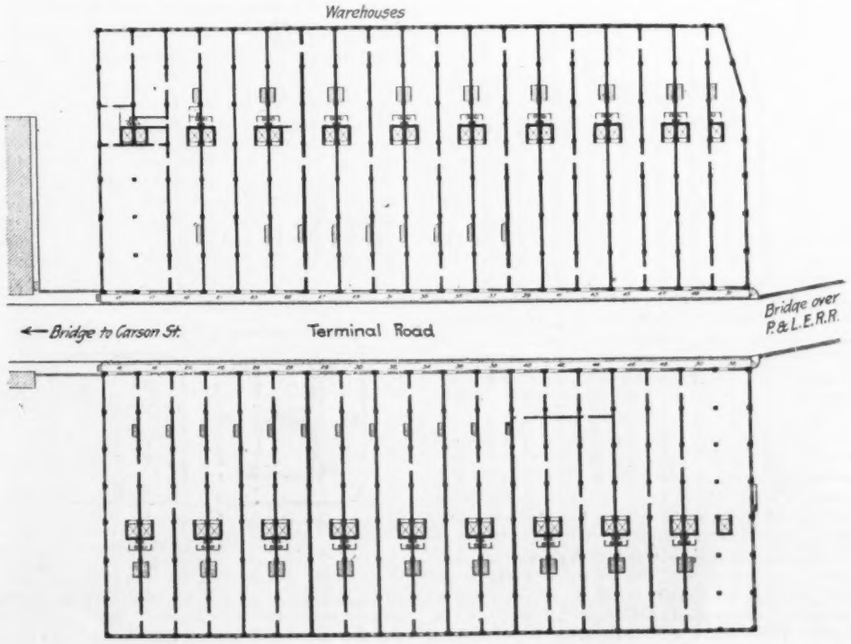


FIG. 2. PLAN OF THIRD FLOOR OF PITTSBURG TERMINAL WAREHOUSE.

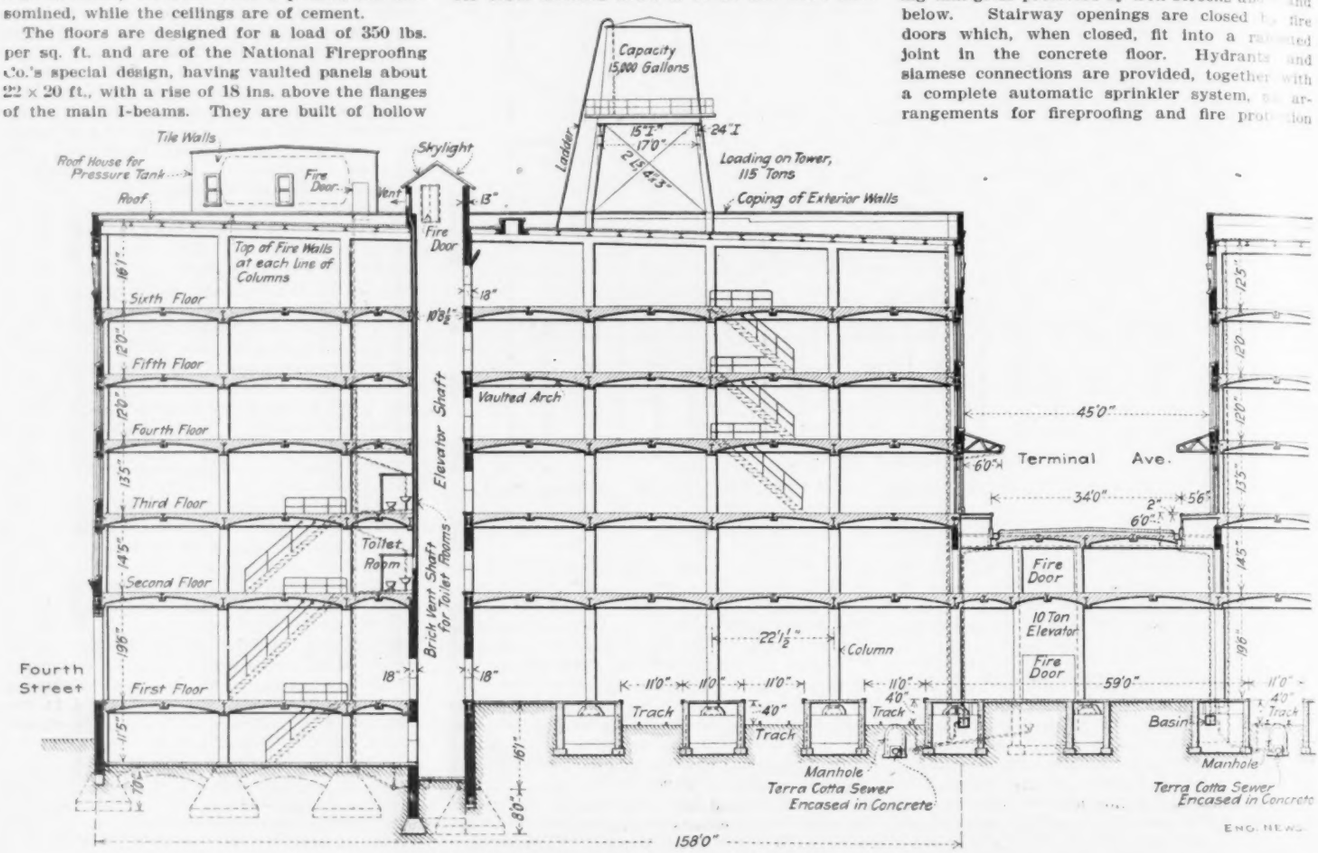
Co., of Pittsburg, and erected by the Oscar Daniels Co., of Chicago. The brick walls are 13 ins. thick between the pilasters, and the sills, etc., are of terra cotta, no stone being used in the exterior walls. Each side of the building is divided into three sections by 18-in. walls, while 13-in. walls are used for the 20-ft. subdivisions. This arrangement was adopted as a precaution against explosions. The walls are of brick, laid in cement mortar, and all division walls are extended 2 ft. above the roof to form fire walls. For the interior finish, the brick work is pointed and kalsomined, while the ceilings are of cement.

The floors are designed for a load of 350 lbs. per sq. ft. and are of the National Fireproofing Co.'s special design, having vaulted panels about 22 x 20 ft., with a rise of 18 ins. above the flanges of the main I-beams. They are built of hollow

position. The I-beams are encased in concrete, as shown in Fig. 8.

The fireproof character of the building is one of its most important features. Its division into sections by 18-in. and 13-in. brick walls has already been mentioned, and in order to ensure against the spread of interior fires it is provided that in case of a tenant occupying several sections, not more than three consecutive sections shall be allowed to communicate with each other; for two sections there may be two openings, but for three sections there is to be not more than

side, so that it should not be necessary to break a window in case of fire and thus cause a draft which cannot be shut off. There are no balance weights, and the window is automatically closed and locked when subjected to a temperature of 130° F., so as to afford a protection against exposure fires. The elevator enclosures are 8-in. brick walls, the openings in which are filled with standard tin-clad fire doors, arranged to close automatically. The enclosures are extended above the roof and covered with skylights having thin glass protected by iron screens above and below. Stairway openings are closed by fire doors which, when closed, fit into a rabbeted joint in the concrete floor. Hydrants and siamese connections are provided, together with a complete automatic sprinkler system, the arrangements for fireproofing and fire protection



Half Cross Section.

FIG. 3. HALF CROSS-SECTION OF PITTSBURG TERMINAL WAREHOUSE.
Charles A. Bickel, Pittsburg, Pa., Architect and Engineer.

porous terra-cotta blocks, 6 ins. deep, 8 ins. wide and not exceeding 12 ins. in length. These are laid diagonally, as shown in Fig. 5. In the construction, the wood centering was suspended by long bolts from timbers laid across the I-beams. The centering was covered with 1 in. of Portland cement, in which the blocks were laid, all joints being filled with cement grout. Such parts of the steel framing as are left exposed by the floor are covered with terra-cotta skewbacks well grouted and the space between the terra-cotta and steel filled solid. The arches are leveled up with concrete well rammed in to all spaces around the beams, and having a minimum thickness of 2 ins. at the crown; this is composed of 1 part cement, 3 parts sand and 6 parts gravel. Above this filling is a concrete floor 2 ins. thick, with sidewalk finish, composed of 1 cement to 2 crushed granite. Fig. 6 shows the steel framing for the groined arches, and Fig. 7 shows the upper and lower sides of the completed arches. The floor in each compartment slopes 1 in. in 20 ft. towards the side away from the stairway opening, and a cement gutter on this side leads the drainage to a 4-in. inside down-spout. The roof is of the Johnston tile block system; over the I-beam framing is laid wire netting embedded in ¾-in. cement mortar (1 cement to 2½ sand), and upon this are laid the hollow tiles, which are then grouted. Over the blocks and the steel framing is a 2-in. bed of concrete, covered with four-ply felt and gravel com-

one opening in each wall, and all openings are fitted with standard fire doors on both sides. The windows have 46,500 sq. ft. of openings, and are fitted with wire glass in steel sashes, furnished by the Phoenix Steel Construction Co., of Pittsburg. The sash frame is made from one piece of steel pressed into shape, and the sill is of cold pressed steel. The cross bars supporting the glass are also of steel and constructed with air spaces of sufficient area to retard heat radiation, being

Fig. 4. Sections of Columns.

thus better adapted to withstand heat than a plain galvanized iron bar. The parts of the sash and framing are put together with rivets, but present no rivet heads on the outside. The sashes are provided with locks, and a master key is furnished which will unlock any sash from the out-

being made under the approval of the National Board of Fire Underwriters.

The sprinkler system is of the Grinnell dry-pipe type, and each of the 38 warehouses is equipped with 171 sprinklers, while the main freight station floor has 1,054 sprinklers. The sprinkling apparatus is divided into 44 sections; each warehouse is protected by one section independent of the others, and the first or main floor is protected by six sections. The sprinkler system is also equipped with an alarm device, and on the first floor are 44 alarm gongs, one for each section. Each section is also connected to the station annunciator located in the engine room of the power plant; in case of fire in any section this will ring the alarm gong in that section and also the gong on the annunciator, while the drop on the annunciator will indicate the location of the sprinkler that opened. The fire extinguishing system is also connected up with six siamese steamer connections.

The water for the plumbing system for the warehouses is distributed from two 15,000-gallon tanks on the roof, which are filled by two pumps in the engine room, taking the water from two tanks on the second floor of the engine room. The offices of the warehouses are heated by direct radiation with exhaust steam from the power plant, which is conducted through a 12-in. pipe in the tunnel under the tracks. The heating system installed is a one-pipe gravity-return sys-

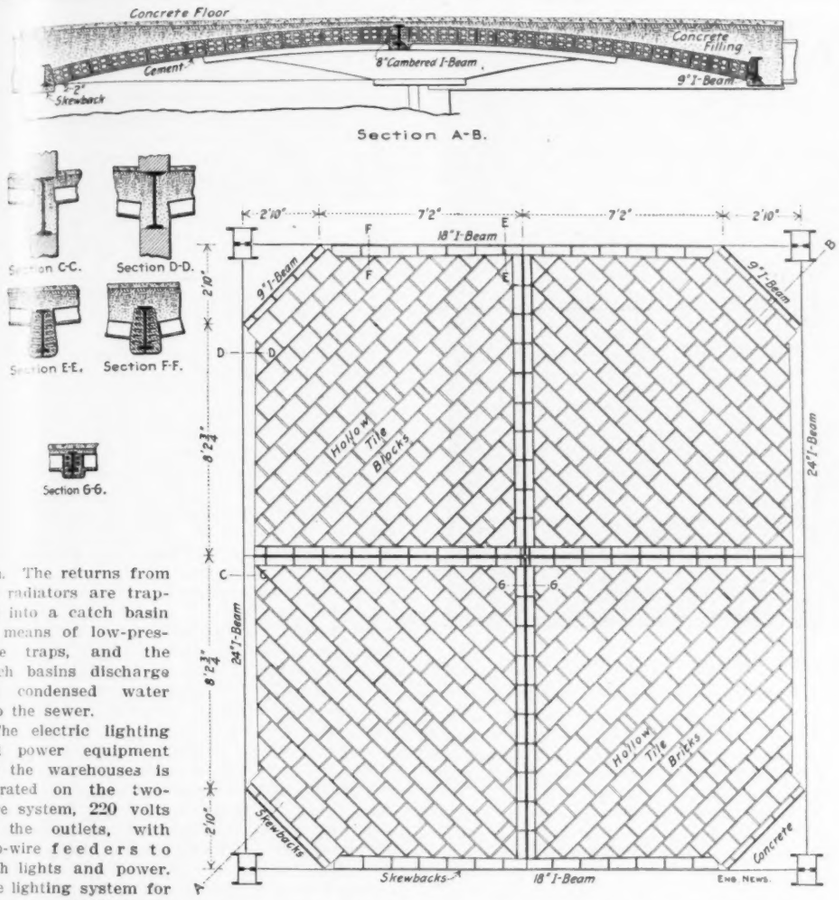


FIG. 5. GROINED ARCH FLOOR CONSTRUCTION, PITTSBURG TERMINAL WAREHOUSE.
National Fireproofing Co., Chicago, Contractors.

tem. The returns from the radiators are trapped into a catch basin by means of low-pressure traps, and the catch basins discharge the condensed water into the sewer.

The electric lighting and power equipment for the warehouses is operated on the two-wire system, 220 volts at the outlets, with two-wire feeders to both lights and power. The lighting system for the entire building is controlled by six main panel boards located on the second floor, to which lead the six main feeder circuits coming from the switchboard in the power plant. There are 12 sub-panel boards on the freight station floor controlling the station lamps. This floor is lighted by 40 Cooper-Hewitt lamps with 26-in. tubes of 300 vertical c. p. The balance of the building is lighted by approximately 4,000 incandescent lamps of 16 c. p. installed on 400 sub-circuits controlled by 400 flush push switches. There are eight main feeder circuits for the elevators and one feeder circuit for machinery motors, which are controlled from the main panel board in the power plant. The main feeder circuits for the lighting and power system are run in enameled steel conduits from the main switchboard in the engine room, over the bridge to the warehouses. The sub-feeder circuits are also run in enameled steel conduits, partly concealed and partly open work.

As already noted, the goods are handled by means of electric freight elevators, one in each warehouse (from basement to top floor), and six in the center of the building from the main platform of the freight station to the platform on the second floor. Each of the 38 warehouse elevators has a lifting capacity of 4,000 lbs. at a speed of 100 ft. per minute. Each of the six freight elevators has a lifting capacity of 6,000 lbs. with a speed of 60 ft. per minute. The elevators are equipped with full magnetic control, safety devices, electric annunciators and semi-automatic safety gates at all landings. The cages are of steel with wooden platforms.

The cold storage department of the warehouses consists of 14 rooms, with a total storage capacity of about 604,200 cu. ft. The rooms are insulated by means of two layers of nonpareil cork boards 2 ins. thick, which are finished on the inside of the room with cement plaster. The cold storage room on the fourth floor can be cooled down to a minimum temperature of 10° F. below zero, and the rooms on the fifth and sixth floors can be cooled down to 20° F. above zero. The cooling is produced by a system of pipe lines through which circulates the cooled brine coming from the refrigerating plant in the power-house. The main brine lines between the brine pumps and the headers in the storage room are run in a tunnel connecting the warehouse with the power plant.

Along the river front of the site is a concrete retaining wall, 400 ft. long, supported on timber piles. A section of the wall is shown in Fig. 9. Drain pipes are carried through the wall, and on the face are ring bolts for tieing up boats and steamers.

POWER PLANT.—The power plant is contained in a separate building on the river bank, as already noted, and the mechanical and electrical equipment was designed and installed under the direction of Kindl & Glafey (now Glafey & Plagwitz), consulting engineers. The power-house is 55 × 184 ft., of steel frame construction, with brick curtain walls, and the structural design is shown in Fig. 10. The engine room has its floor 2 ft. above the highest recorded high-water level, and is served by a 10-ton hand traveling crane. Above it is a floor for tanks, etc. Owing to the difference of approximately 34 ft. between the high and low water levels of the river, it was necessary to build a pump pit 26 ft. deep below the main floor in order to bring the pumps within reasonable suction height from the low-water level. In this pit are located three 1,000-gallon fire pumps, two for the automatic sprinkler system and one for general service. They are cross connected in such a manner that any one of the three can be used for either purpose. The general service pump lifts the water into two tanks 18 ft. diameter and 10 ft. high, on the second floor of the engine room; these supply the water required in the power plant and in the warehouses. Room is also provided for two additional pumps for two artesian wells, which give water at an average temperature of 54° F. This water is to be used as cooling water for the ammonia condensers of the refrigerating machines. The three fire pumps draw their water from the intake well 16 ft. diameter and 44 ft. deep, which is directly behind the river retaining wall and receives its water from the main intake pipe through this wall. The well is provided with two sets of wire screens, and the intake pipe is provided with a sluice gate which shuts the water off to allow of cleaning the well.

The boiler plant consists of six Babcock & Wilcox water-tube boilers of 250 HP. each, arranged in three batteries, and carrying 160 lbs. pressure. They are fitted with Roney mechanical stokers,

FIG. 6. STEEL FRAMEWORK FOR FLOORSYSTEM.

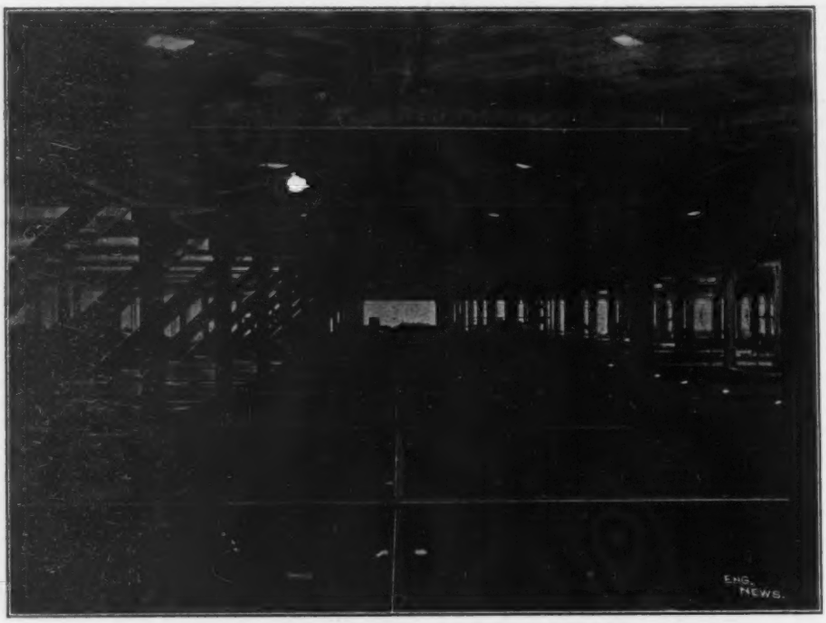


FIG. 7. VIEW SHOWING GROINED ARCH FLOOR AND CEILING.

the coal being fed from bins overhead and in front of the boilers through coal chutes provided with spreaders to distribute the coal over the full width of the stoker grates. There are six bins, one for each boiler, of 80 tons capacity each. Coal is delivered in bottom dump cars on a siding, discharged into a track hopper and distributed into the storage bins in front and above the boilers by means of a continuous bucket elevator and a drop-flight chain conveyor. The same apparatus handles the ashes. The smokestack is of perforated radial-brick construction, with an inside top diameter of 7 ft. 6 ins. and a height of 145 ft. The feed water is heated in an open feed-water heater and treated in a Scaife water softening and purifying plant, in order to remove all scale forming and corrosive elements before it enters the boilers.

The brine required for the cold storage plant is cooled in two refrigerating machines of the ammonia absorption type, which can be operated with either exhaust or live steam. Each machine has a cooling capacity equal to that of 75 tons of melting ice per 24 hours, and is capable of cooling 375 gallons per minute of calcium chloride brine of 1.225 specific gravity and of 0.7 specific heat through a range of 5° F. with the outlet brine at 5° below zero. There are two pumps for circulating the brine.

There are three direct-current engine-type generators, each of 200 KW. capacity, 250 volts, 8 poles, running at 250 revolutions per minute, and directly connected to Westinghouse engines of the compound vertical single acting type. The switchboard has eight panels, and the buss bars are split so that power and light circuits are fed from separate busses. An integrating wattmeter is installed on both power and light busses, and all feeder circuits are protected by both circuit breaker and fuse.

All the steam and water pipes between the power house and the warehouse are carried in a 6-ft. brick tunnel, the construction of which is plainly shown in Fig. 11. The electric conduits are carried over the bridge connecting the two buildings.

THE COMPARATIVE ADVANTAGES OF HARD AND SOFT STEEL FOR REINFORCING CONCRETE.

By Daniel B. Luten.*

Among designers of reinforced concrete structures, two factions appear to have arisen, one advocating the use of hard steel having an elastic limit of 55,000 to 60,000 lbs. per sq. in., the other favoring soft steel with elastic limit of 35,000 to 40,000 lbs. per sq. in. The arguments advanced by both sides are very evenly balanced; for hard steel the following four advantages are claimed, of which the first two are undoubtedly imaginary while the two latter are sound: (1) Greater efficiency; (2) less liability of the concrete to crack; (3) cheaper quality of steel; (4) superfluous factor of safety. For soft steel, four advantages also are advanced, of which all appear to be sound. (1) Greater reliability; (2) more easily obtainable; (3) readily workable; (4) increased adhesive surface.

*President National Bridge Co., Indianapolis, Ind.

The greatest advantage claimed for hard steel is that it is more efficient as a reinforcement than soft steel, since it admits of using a higher working stress. Numerous discussions have appeared in the Proceedings of the American Society of Civil Engineers, and in the technical journals during the past year, attempting to show by mathematical analyses, the most economical percentage of steel to be used in reinforcing concrete beams, and in every case basing the determination on the elastic limit of the steel. On this assumption, most writers agree that from 1% to 1.4% of the cross-sectional area of the beam is required for soft steel and from 0.7% to 1% for hard steel.

This assumption requires, however, that the beam remain safe and of satisfactory design until the steel has reached its elastic limit; in other words, that the failure of the steel determines the failure of the beam. This seems to the writer an arbitrary and unwise assumption. It is conceded by everyone that long before the steel has reached its elastic limit, the concrete at the stressed edge will show numerous cracks plainly visible to the naked eye, which are not conducive to an appearance of permanence or stability, and may in extreme cases even endanger the embedded steel by permitting corrosion. Surely no architect, engineer or builder will knowingly erect a reinforced concrete beam or girder with the expectation that when loaded either with permanent load or with moving load, it will develop visible cracks, even if those cracks do not indicate failure of the structure. Such cracks are extremely unsightly. A visible crack adjacent to heavy reinforcement as in the lower edge of a concrete beam, is a sign of danger, which is one of the advantages of reinforced concrete over steel skeleton construction. A steel structure will usually fail without warning, while the reinforced concrete structure gives warning by visible cracks before the ultimate strength of the structure is reached. If it be assumed that the concrete should be permitted to crack and that such cracks are not to be considered in determining the design of the beam, and that the strength of the beam is to be based on the elastic limit of the steel, then we lose this important advantage of reinforced concrete, the giving of a signal of danger, before the ultimate strength is approached.

It would appear much more reasonable to assume that the beam has reached its limit of usefulness when cracks become apparent, in other words to design with a certain limit of stress in the steel which will not permit visible cracking of the concrete. What this stress may be is not at the present time well understood, and it is rather an indefinite measure since cracks may become visible to expert eyes much sooner than

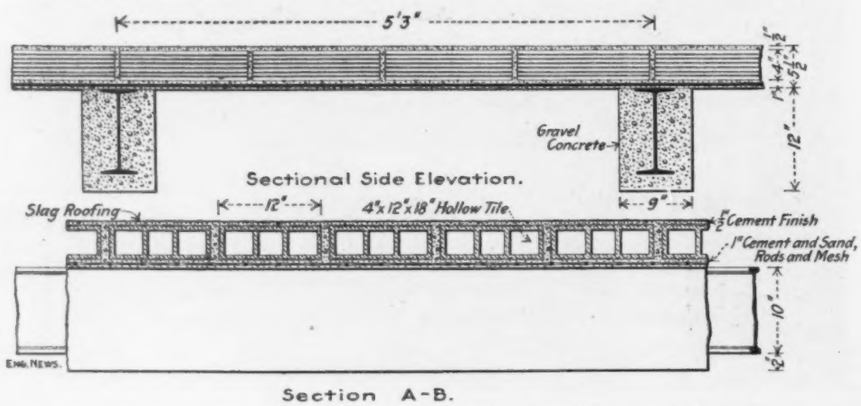


FIG. 8. ROOF CONSTRUCTION OF PITTSBURG TERMINAL WAREHOUSE.

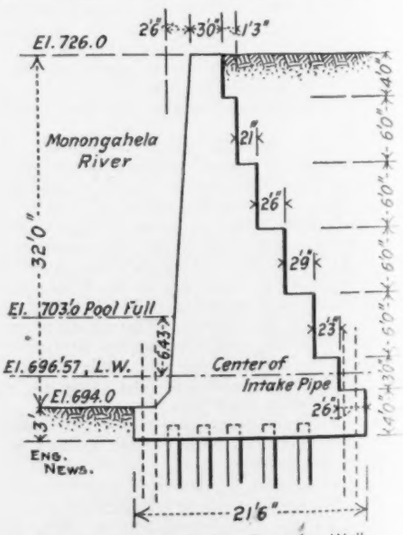


Fig. 9. Section of River Retaining Wall.

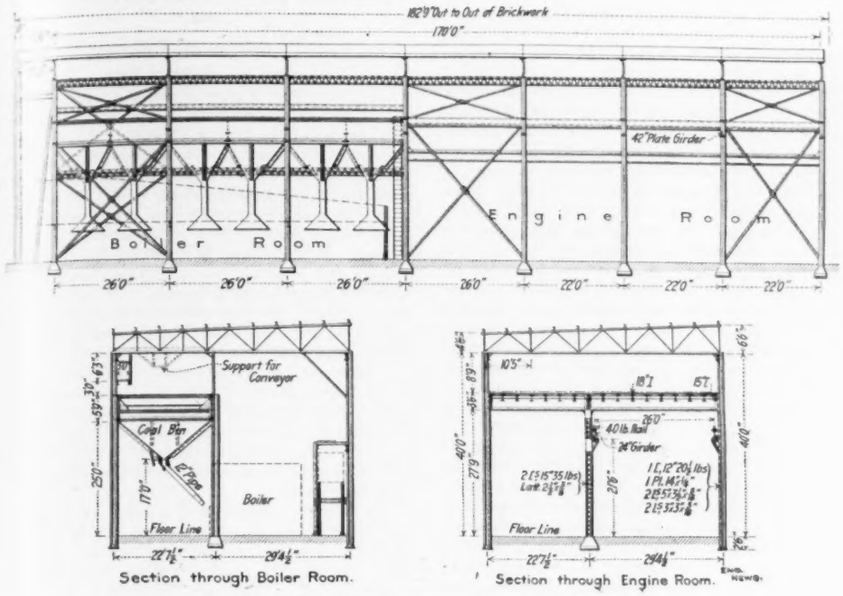


FIG. 10. STRUCTURAL DESIGN OF POWER-HOUSE.

to those not trained in inspection. But the principle that some such standard should be adopted instead of the elastic limit of the steel will enable us to arrive at a conclusion as to the relative merits of hard and soft steel, without our attempting more specifically to define the exact amount of the limiting stress.

It is a well known fact that by moistening the concrete, cracks can be detected when the steel is subjected to but 6,000 or 8,000 lbs. per sq. in., but they require expert methods of detection and have been shown to be of no danger to the safety of the structure. In dry concrete beams, cracks become visible to the naked eye on very careful inspection when the steel is stressed to 20,000 or 25,000 lbs. per sq. in. For the layman, who is not an expert in such matters, a stress of 30,000 lbs. per sq. in. would probably be necessary to produce visible cracking.

The point to the above discussion lies in the fact that soft steel and hard steel have practically the same coefficient of elasticity, varying only from 29,000,000 to 32,000,000, in extreme cases. Hence for the same intensity of stress the stretch of the two kinds of steel is almost exactly the same, regardless of the elastic limit of the steel. An increase in the percentage of carbon in the steel does not materially increase the coefficient of elasticity, although it does increase the elastic limit.

A bar of high tension steel 1 in. square will show the same stretch as a bar of low tension steel of the same section under an applied load of ten tons say. If now we attempt to take advantage of the 50% greater elastic limit of hard steel by using correspondingly less metal to support the ten tons, the hard steel bar will show a proportionately greater stretch than the soft bar of larger section. Since stretch of the steel is the cause of the cracking of the concrete, we evidently cannot hope to make any practical use of the higher tensional value of hard steel, unless we at the same time admit that we have no objection to cracks in the concrete.

An analysis of designs made by advocates of high tension steel invariably shows that they are overloaded with steel, frequently having 300 or 400% more of hard steel than would under any circumstances be required even of soft steel. When challenged with this fact their reply is that they are afraid the contractor might omit some of the steel, and they have therefore provided a liberal allowance. Unfortunately when the contractor hears this excuse he usually does omit a part of it.

In the Journal of the Western Society of Engineers for December, 1905, Mr. Harding presents a paper (Eng. News, Feb. 15, 1906) on tests of reinforced concrete beams made by him. Mr. H. P. Boardman in discussing this paper adds the following pertinent informataion regarding these tests:

> It may be interesting to note the stage in these tests at which the first crack was noticed . . . . . there being a man on each side of the beam watching for cracks. A pause was made after each increment in the applied load, and a search made for new cracks. Taking the average for each set of three beams the following are approximately the unit stresses in the steel at the time of observing the first cracks:

Set	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Unit stress, lbs.	25,000	21,000	24,000	18,000	25,000
Kind of bar	Ransome	Ransome	Ransome	Kahn	Johnson
Elastic limit, lbs.	54,000	54,000	54,000	35,000	54,000
Set	**No. 6.**	**No. 7.**	**No. 8.**	**No. 9.**	**No. 10.**
Unit Stress, lbs.	21,000	22,000	22,000	19,000	21,000
Kind of Bar	Johnson	Plain O	Plain O	Johnson	Johnson
Elastic limit, lbs	54,000	35,000	35,000	54,000	54,000

Mr. Boardman adds that some of the sets of beams showed cracks at the same stress for all three beams, while others varied as greatly as 30%. This, however, was to be expected, as the detection of such cracking is not an accurate measure. Each set consisted of three beams reinforced near the lower edges by bars of the kinds named, and arranged to provide for both tension and shear.

Since the stress at which visible cracks appear is considerably below the elastic limit even of soft steel, it is not material what the exact stress is at which the cracks become visible; but it is important that we assume such a factor of safety that the stress in the steel will never exceed from 20,000 to 30,000 lbs. per sq. in. Nothing could show more conclusively than this series of tests that hard steel has no advantage over soft steel in efficiency provided it is granted that the beam has reached its limit of usefulness when badly cracked.

The advocates of hard steel have also urged that concrete would be less liable to crack if reinforced with hard steel instead of soft, since the steel stands a higher intensity of stress. This argument, however, overlooks the fact that the coefficients of elasticity of the two metals are the same. If the same area of reinforcement is employed for both hard and soft steel, then the amount of cracking should be the same for both; and if the amount of hard steel be reduced in section to take advantage of its greater strength, then exactly the reverse of what is claimed should occur, and the beam reinforced with the lesser percentage of hard steel will show most cracks. If hard steel and soft steel can both be secured in good quality at the same price per pound, they will show the same efficiency, and neither will show any advantage over the other in freedom from cracking. Beams reinforced with any kind of reliable steel should have the same percentage of reinforcement regardless of elastic limit.

Most of the hard steel now being sold for reinforcing purposes is manufactured by a process of re-rolling old steel rails, and is ordinarily purchaseable at from 10 to 20% lower prices than open hearth steel. The addition of deformations does not add materially to its cost. Such steel is now purchaseable from the manufacturers when no proprietary devices are involved for about 1.5 cts. per lb. Open hearth steel is worth approximately 1.75 cts. per lb. The re-rolling of old steel rails does not give a uniform product nor one that is reliable under impact stresses. But if this steel is as good as or better than soft

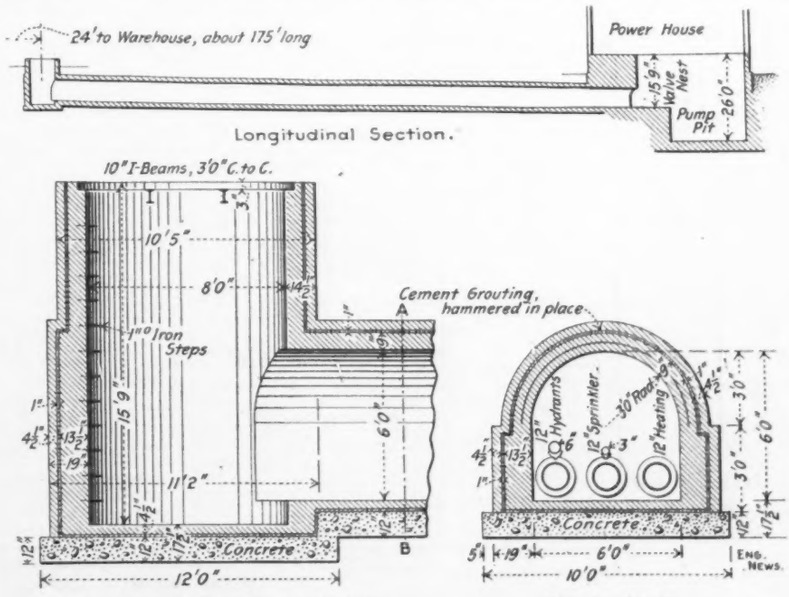


FIG. 11. PIPE TUNNEL CONNECTING POWER-HOUSE WITH WAREHOUSE.

steel in other respects then the lower cost is an advantage of about 15%, and in this sense hard steel may be considered to be the more efficient of the two.

To offset the disadvantage of brittleness and lack of uniformity of most hard steel, it has what may be termed a superfluous factor of safety in that if the steel has been so designed as to avoid cracking and the same percentage specified whether of hard or soft steel, the fact still remains that a beam reinforced with hard steel will carry 50% more before ultimate failure than a beam reinforced with soft steel, although it will, of course, long since have failed so far as appearance and soundness are concerned. The hard steel provides, therefore, a greater factor of safety than the soft steel, but since it cannot be taken advantage of without practically destroying the beam it is superfluous and of almost no practical value.

Soft steel has the advantage of having been on the market for years in sections suitable for tensional reinforcement, and is consequently readily obtainable at any time or place, manufactured by open hearth process, and of more uniform and reliable quality than the re-rolled Bessemer steel. Hard steel can, of course, also be manufactured by this process in uniform and reliable grades, but because there has been no demand for it, not hitherto fully supplied by the cheaper re-rolled steel, such hard steel is not readily procurable and must be manufactured to order.

Soft steel is readily workable and can be welded into continuous lengths by a moderately skilled blacksmith. Hard steel calls for extreme skill to secure satisfactory results. Since, however, nearly all connections can be made by anchoring in the concrete there is no great advantage gained except in special cases in using steel that can be welded.

If hard steel is to be used in less percentage than soft steel, because of its greater tensile strength, then the lesser percentage of hard steel of course presents less adhesive surface to the concrete, and should therefore be used in smaller sizes to offset this difference. For the exposed surfaces of rods or bars vary as the diameter, while the area of section of the metal varies as the square of the diameter. The greatest amount of exposed surface and consequently the greatest degree of adhesion will be secured by working with as small tension members as practicable. Such an arrangement has, moreover, the additional advantage of distributing the reinforcement more thoroughly through the concrete, assuring greater harmony of action between the two materials. It is doubtful if steel in larger sizes than ¾-in. rods is desirable except in some extreme cases, and ⅝ and ½ in. are much to be preferred if they do not interfere too greatly with the placing of the concrete. Round rods provide less actual area than square bars or flat bars, but this is more than compensated by the greater certainty of properly embedding the round rods. Concrete will rarely enclose a square bar securely from below, and if square bars are to be used they should be placed diamond fashion, that is with the faces inclined. For similar reasons flat bars should be used only in vertical reinforcement.

To summarize then, if hard steel and soft are readily procurable in reliable quality at the same cost, neither possesses any marked advantage over the other for reinforcement, and steel of any usual elastic limit may be used in properly designed structures without reference to its percentage of carbon.

A LANDSLIDE caused by a cloudburst is reported from Ocampo, Chihuahua, Mexico. The place is a mining camp on a mountain side, and most of the buildings in it were carried away. Ten deaths are reported.

A UNIVERSAL DICTIONARY OF MECHANICAL [illegible] ING.*

By George H. Follows.†

Part XI.—Standard Data.

149. In every manufacturing concern [illegible] world there are certain facts and certain me[illegible] —in other words certain "data"—that are [illegible] over and over again. When these data are [illegible] lected, classified and tabulated for general [illegible] they are called *standard* data.

150. In many drafting rooms the importan[illegible] of collecting standard data is recognized, bu[illegible] manner of tabulating is probably not the [illegible] in any two drafting rooms in existence. Th[illegible] is unfortunate, because it makes it inconvenie[illegible] to bind together the data collected by different [illegible] and different firms—data of general value [illegible] might otherwise be made use of in the com[illegible] tion of a standard book for universal use.

151. The main objects in view here are to sug[illegible]gest for the adoption of drafting rooms in gene[illegible]ral a standard size for standard data sheets, and to present some methods of tabulating that have been developed with the idea of making the data easy to read.

152. The dimensions and general arrangement suggested for the sheet are given in Fig. 39, with an inset illustration of the "master tracing" which carries a special record strip for the recording of sub-number changes. The sub-numbers and their dates are repeated in the lower margin of the trimmed sheet; the same margin also carries the firm name and address, signatures and drawing number; leaving a clear rectangle for the data The trimmed sheet is the same size as the widely known Carpenter section paper, 12½ in. × 8½ in., small enough to handle com-

*Copyright, 1906, by the Engineering News Publishing Co. Part X. was published in Engineering News for July 12, 1906.

†The Park View, East Liberty, Pittsburg, Pa.

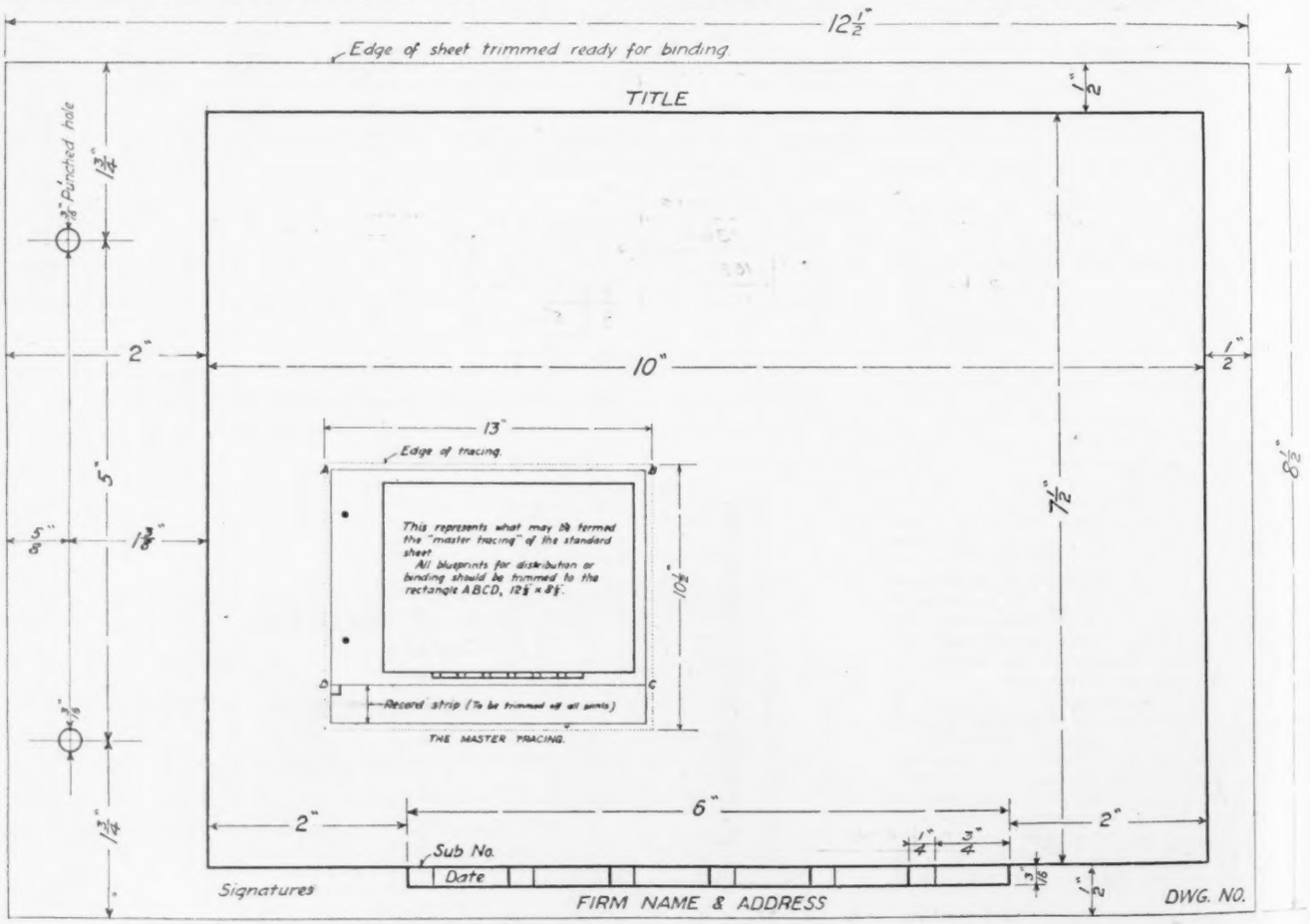


FIG. 39. DIMENSIONS AND FORM OF STANDARD DATA SHEET.

formably when bound in book form, yet large enough for the clear tabulating of data.

153. When putting together a page of data for general reference it is impossible to be too careful about the arrangement and ruling of the sheet. Data should always be easy to read, and every sheet should contain such explanatory notes as are necessary to make the meaning of it all perfectly clear.

154. Figs. 40 to 43 are four pages from the standard book of the Westinghouse Company, introduced here to illustrate certain methods of tabulating that have been found decidedly helpful. The reader will easily realize that the sheets were compiled with considerable care, but his attention is directed particularly to the *studied irregularities* in the arrangement of the columns and in the general ruling of each sheet. Thus, in Fig. 40 the columns are purposely *staggered*—this makes them stand out far more clearly than if they were all on the same level; then every fourth horizontal line consists of short heavy dashes—these are *guide lines* for the eye, and make it easy to follow horizontally from one item to another. Without guide lines it is easy when reading across a page of columns to get on to the wrong line. In Fig. 41 modifications of the same features are used; the vertical columns in the lower half of the table are purposely staggered in relation to those in the upper half, and heavy-dash guide lines are again employed. In Fig. 42 the *headings* are the principal feature; they are arranged in striking "groups," and the rulings for them are made irregular—another example of staggering. The notable feature of Fig. 43 is the manner of indicating the bolt lengths in the horizontal head line, ⅜ to 15, after the fashion of a graduated scale; here also the use of guide lines is an important feature, heavy horizontal and vertical lines being introduced at such intervals as to make it easy to refer quickly to any required size of bolt. But perhaps enough has been said to show that in making up sheets of this kind there is room for the exercise of a great deal of care and ingenuity.

155. It is the writer's hope that the engineering profession will adopt the size and style of standard sheet presented here—or some other on similar lines—and that the time will come when the valuable data now worked out or collected, and put together for the rather selfish use of individuals or single firms, will be generously distributed, through some such channel as Engineering News, for the benefit of the entire engineering fraternity.

ANNUAL CONVENTION OF THE AMERICAN WATER-WORKS ASSOCIATION.

The twenty-sixth annual convention of the American Water-Works Association was held at Boston, July 10 to 14. The attendance was large. The business and social programs were full, well selected and well presented. A large percentage of the papers dealt with the pollution and the purification of public water supplies, a special feature of the program being a review of the Chicago Drainage Canal case by a large number of the technical experts engaged on one or the other side of the suit. Another notable feature of the convention was the large number of new members elected, no less than 101 names being presented and accepted at the first session alone.

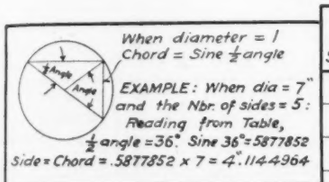
The usual addresses of welcome were followed by the presidential address, by Mr. Benj. C. Adkins, Water Commissioner of St. Louis, Mo., by the routine reports of the officers of the association and by various committee reports.

For the Committee on Electrolysis, Mr. Dabney H. Maury, Chairman (Peoria, Ill.), reported that there had been no developments within the year that warranted changing the previous recommendations of the committee. The lawsuits brought by water departments and companies on account of damages due to electrolysis are all in statu quo. The committee was continued.

STANDARD SPECIFICATIONS FOR CAST-IRON PIPE.

The Committee on Water-Works Standards, through Mr. Charles A. Hague (New York), submitted to the association a form of specification for cast-iron pipe drawn by Mr. Hague. The specification was not even discussed, but the committee was continued. From the report of the committee it appears that a sub-committee of three, at the suggestion of the late J. J. R. Croes, formerly chairman of the main committee, secured the appointment of conference committees on cast-iron pipe specifications from the New England Water-Works Association, the American Society for Testing Materials, the Western So-

UNIT CHORDS


When diameter = 1
Chord = Sine ½ angle
½ Angle
Angle
EXAMPLE: When dia = 7" and the Nbr. of sides = 5: Reading from Table, ½ angle = 36°. Sine 36° = .5877852
Side = Chord = .5877852 x 7 = 4".1144964

Nbr. of Sides	½ Angle	Unit Chord.
3	60°	.8660254
3½	51°-25'-43"	.7709081
4	45°	.7071068
4½	40°	.6427871
5	36°	.5877852
5½	32°-43'-38"	.5406401
6	30°	.5
6½	27°-41'-32".30	.4647408
7	25°-42'-51".42	.4338837
7½	24°	.4057366
8	22° 30'	.3826834
8½	21°-10'-35".3	.3612528
9	20°	.3420201
9½	18°-56'-50".526	.3247123
10	18°	.3090170
10½	17°-8'-34".28	.2947622
11	16°-21'-49.09	.2817325
11½	15°-39'-7".826	.2697980
12	15°	.2588190
12½	14°-24'	.2486899
13	13°-50'-46".15	.2393157
13½	13°-20'	.2306159
14	12°-51'-25".71	.2225208
14½	12°-24'-49".65	.2149756
15	12°	.2079116
15½	11°-36'-46".45	.2013027
16	11°-15'	.1950903
16½	10°-54'-32".72	.1892537
17	10°-35'-17".64	.1837495
17½	10°-17'-8".57	.1785574
18	10°	.1736481
18½	9°-43'-47".02	.1690030
19	9°-28'-25".26	.1645945
19½	9°-13'-50".77	.1604140
20	9°	.1564344
20½	8°-46'-49".74	.1526516
21	8°-34'-17".14	.1490422
21½	8°-22'-19".53	.1455536
22	8°-10'-54".54	.1423148
22½	8°	.1391731
23	7°-49'-33".91	.1361666
23½	7°-39'-34".46	.1332880
24	7°-30	.1305262
24½	7°-20'-49"	.1278787
25	7°-12	.1253332
25½	7°-3'-31".76	.1228892
26	6°-55'-23".077	.1205367
26½	6°-47'-32".83	.1182739
27	6°-40'	.1160929
27½	6°-32'-43".63	.1139923
28	6°-25'-42".85	.1119644
28½	6°-18'-56".84	.1100094
29	6°-12'-24".82	.1081189
29½	6°-6'-6".10	.1062936
30	6°	.1045284
31	5°-48'-23".22	.1011683
32	5°-37'-30"	.0980171
33	5°-27'-16".36	.0950560
34	5°-17'-38".82	.0922683
35	5°-8'-34".28	.0896392
36	5°	.0871557
37	4°-51'-53".51	.0848058
38	4°-44'-12".63	.0825793
39	4°-36'-55".38	.0804665
40	4°-30'	.0784591
41	4°-23'-24".87	.0765492
42	4°-17'-8".57	.0747301
43	4°-11'-9".76	.0729952
44	4°-5'-27".27	.0713391
45	4°	.0697565
46	3°-54'-46".95	.0682424
47	3°-49'-47".23	.0667926
48	3°-45'	.0654031
49	3°-40'-24".49	.0640702
50	3°-36'	.0627905
51	3°-31'-45".88	.0615609
52	3°-27'-41".53	.0603784
53	3°-23'-46".41	.0592405
54	3°-20'	.0581448
55	3°-16'-21".81	.0570887
56	3°-12'-51".42	.0560704
57	3°-9'-28".42	.0550877
58	3°-6'-12".41	.0541388
59	3°-3'-3".05	.0532221
60	3°	.0523360
61	2°-57'-2".95	.0514787
62	2°-54'-11".61	.0506491
63	2°-51'-25".71	.0498458
64	2°-48'-45"	.0490676
65	2°-46'-9".23	.0483133
66	2°-43'-38".18	.0475819
67	2°-41'-11".64	.0468722
68	2°-38'-49".41	.0461834
69	2°-36'-31".30	.0455145
70	2°-34'-17".14	.0448648
71	2°-32'-6".76	.0442333
72	2°-30'	.0436194
73	2°-27'-56".71	.0430222
74	2°-25'-56".75	.0424411
75	2°-24'	.0418757
76	2°-22'-6".31	.0413249
77	2°-20'-15".58	.0407885
78	2°-18'-27".69	.0402659

1	Mar. 4.03	2	Apr. 11.03

WESTINGHOUSE ELECTRIC & MFG. CO., PITTSBURG, PA.

81255

FIG. 40. SAMPLE PAGE FROM WESTINGHOUSE BOOK OF STANDARD DATA SHEETS.

ciety of Civil Engineers and the American Manufacturers' Committee. It proved difficult to get together even a small portion of the conference committee, and when the conclusions of these few were submitted, by letter, to the other members of the committee for discussion, the proposed specifications "met with such general opposition" that there was believed to be "no chance whatever of an agreement upon other lines by the conference committee." Unfortunately, the report is not perfectly clear on all the points involved. The only differences of opinion stated in the report relate to the number of classes into which cast-iron pipe should be divided. Mr. Walter Wood (Philadelphia), representing the American Society for Testing Materials, and Messrs. Hague and Theo. A. Leisen (Wilmington, Del.), for the American Water-Works Association, conditionally compromised on two different outside diameters for each nominal inside diameter and on further division by heads 100 ft. apart, making four classes of pipe only. But the full American Association subcommittee (including J. Waldo Smith, of New York), favored a single outside instead of two outside diameters, and changes at each 50 ft. of head, instead of each 100 ft., making seven classes of pipe. The compromise not meeting with general approval outside the four who agreed to it, and "agreement on other lines" being considered equally impossible, the "Chairman of the Standard Committee" [that is, the original American Association committee] "decided to submit the single diameter specification." This specification, with tables of dimensions, etc., also by Mr. Hague, was printed, with advance papers, and circulated before and at the meeting. As already stated, the report was received without action, further than the continuation of the committee on water-works standards.

WATER POLLUTION AND PURIFICATION.

The program contained a large number of papers on water pollution, water purification and allied subjects, consideration of which will be grouped together here. Mr. F. A. W. Davis (Indianapolis) presented an illustrated paper dealing with water and water purification in general and more particularly with the new slow sand filtration plant of the Indianapolis Water Co. The beds are provided with perforated rectangular tile underdrains that form a complete floor for the filtering material, which consists of 1 ft. of graded gravel and 3 ft. of fine sand. The beds are roofed with reinforced concrete. A clear water basin, a 48-in. reinforced concrete conduit 6,000 ft. long, and a 30,000,000-gallon triple expansion pumping engine have recently been built by the company. An independent laboratory building, with equipment, has been provided.

The next paper was a brief one on "Sewage Disposal and Public Water Supplies," by M. N. Baker, of the editorial staff of this journal. The main points of the paper were that water purification, rather than sewage purification, must be depended on for the protection of public water supplies against sewage; that more accurate and complete typhoid and other vital statistics are needed, and that where a high degree of sewage purification is necessary some of the preliminary processes for removing solids, like sedimentation or septic action, may be followed by contact beds or percolating filters, then by a brief period of sedimentation, and finally by intermittent filtration through sand. Or, in place of the latter, mechanical filters might be employed. Appended to the paper are brief descriptions of typical processes of sewage treatment, and also a short list of books on water and on sewage purification.

Mr. M. O. Leighton, of the U. S. Geological Survey, presented a paper on "River Pollution: A Discussion of Its Present Status and Suggestions Concerning Remedial Policy." He maintained that on densely populated drainage areas pollution rendering the water unfit for domestic consumption, without purification, is inevitable, but that pollution so gross that the river water "cannot be readily purified by reasonable and economical methods," or that the water cannot be used for boiler purposes, or that a nuisance is created, should be prohibited. Mr. Leighton also urged that the appeal against pollution be based on economic grounds; that a concerted effort be made to secure a congressional act against the pollution of interstate streams, or, if that is held to be unconstitutional, then uniform state legislation to the same end. The following was suggested in definition of "polluting substances that should be proscribed by law":

Any liquid which contains a greater number of parts by weight of suspended matter, or of the salts of sal-

WEIGHTS OF ROUND BAR PER INCH OF LENGTH.

DIA. IN 16THS INCHES	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	12"	13"	14"	15"	16"	17"	18"
0	0	0.2223	0.891	2.01	3.57	5.58	8.03	10.93	14.28	18.07	22.31	27.00	32.13	37.70	43.72	50.19	57.10	64.46	72.27
1/16	0.00087	0.2509	0.9455	2.09	3.68	5.72	8.20	11.13	14.50	18.32	22.59	27.30	32.46	38.06	44.11	50.61	57.55	64.94	72.77
1/8	0.0035	0.2823	1.01	2.18	3.80	5.86	8.37	11.33	14.73	18.58	22.87	27.61	32.80	38.42	44.50	51.03	57.99	65.41	73.28
3/16	0.0078	0.3134	1.07	2.27	3.91	6.00	8.54	11.52	14.95	18.83	23.15	27.92	33.13	38.79	44.90	51.45	58.45	65.89	73.78
1/4	0.0139	0.3473	1.13	2.36	4.03	6.15	8.71	11.73	15.18	19.09	23.44	28.24	33.48	39.16	45.29	51.87	58.90	66.37	74.29
5/16	0.0217	0.3829	1.19	2.45	4.14	6.30	8.89	11.93	15.41	19.34	23.72	28.54	33.81	39.53	45.69	52.30	59.35	66.85	74.80
3/8	0.0312	0.4202	1.26	2.54	4.27	6.45	9.07	12.13	15.65	19.61	24.01	28.87	34.17	39.90	46.09	52.73	59.81	67.34	75.31
7/16	0.0425	0.4593	1.33	2.64	4.39	6.60	9.25	12.34	15.88	19.87	24.30	29.19	34.51	40.28	46.49	53.16	60.27	67.82	75.82
1/2	0.0556	0.5	1.39	2.73	4.52	6.75	9.43	12.55	16.12	20.13	24.60	29.50	34.86	40.65	46.90	53.59	60.73	68.31	76.34
9/16	0.0703	0.5426	1.46	2.83	4.64	6.90	9.61	12.76	16.36	20.40	24.89	29.83	35.21	41.03	47.30	54.02	61.19	68.80	76.86
5/8	0.0868	0.5869	1.54	2.93	4.77	7.06	9.79	12.97	16.60	20.67	25.19	30.15	35.56	41.41	47.71	54.46	61.65	69.29	77.38
11/16	0.1051	0.6329	1.61	3.03	4.90	7.22	9.98	13.18	16.83	20.93	25.48	30.47	35.91	41.79	48.12	54.89	62.11	69.78	77.90
3/4	0.1250	0.6807	1.69	3.14	5.03	7.38	10.16	13.40	17.08	21.21	25.78	30.80	36.27	42.17	48.53	55.33	62.58	70.28	78.42
13/16	0.1467	0.7302	1.76	3.24	5.17	7.54	10.35	13.61	17.32	21.48	26.08	31.12	36.62	42.56	48.94	55.77	63.05	70.77	78.94
7/8	0.1702	0.7814	1.84	3.35	5.30	7.70	10.54	13.84	17.57	21.76	26.39	31.46	36.98	42.94	49.35	56.21	63.52	71.27	79.47
15/16	0.2053	0.8344	1.92	3.46	5.44	7.86	10.74	14.05	17.82	22.03	26.68	31.79	37.33	43.33	49.77	56.66	63.99	71.77	79.99

DIA. IN 16THS INCHES	19"	20"	21"	22"	23"	24"	25"	26"	27"	28"	29"	30"	31"	32"	33"	34"	35"	36"
0	80.52	89.22	98.37	107.96	118.00	128.48	139.41	150.78	162.61	174.87	187.59	200.75	214.35	228.41	242.91	257.85	273.24	289.08
1/16	81.05	89.78	98.94	108.57	118.64	129.17	140.10	151.51	163.36	175.65	188.39	201.58	215.22	229.30	243.82	258.79	274.21	
1/8	81.59	90.34	99.54	109.19	119.28	129.82	140.81	152.24	164.12	176.44	189.21	202.42	216.09	230.19	244.75	259.75	275.24	
3/16	82.12	90.90	100.13	109.81	119.93	130.49	141.51	152.97	164.87	177.22	190.02	203.27	216.95	231.09	245.67	260.70	276.18	
1/4	82.66	91.47	100.72	110.43	120.57	131.17	142.21	153.70	165.63	178.01	190.84	204.11	217.83	231.99	246.60	261.66	277.16	
5/16	83.19	92.03	101.32	111.05	121.22	131.85	142.92	154.43	166.39	178.80	191.65	204.95	218.70	232.89	247.53	262.61	278.14	
3/8	83.73	92.60	101.91	111.67	121.87	132.53	143.62	155.17	167.15	179.59	192.47	205.80	219.57	233.79	248.46	263.57	279.13	
7/16	84.27	93.17	102.51	112.29	122.52	133.20	144.33	155.90	167.92	180.38	193.29	206.64	220.44	234.69	249.38	264.52	280.11	
1/2	84.82	93.74	103.11	112.92	123.18	133.89	145.04	156.64	168.68	181.18	194.11	207.50	221.32	235.60	250.32	265.49	281.10	
9/16	85.36	94.31	103.71	113.55	123.84	134.57	145.75	157.38	169.45	181.97	194.93	208.34	222.20	236.50	251.25	266.45	282.09	
5/8	85.91	94.88	104.31	114.18	124.50	135.26	146.47	158.12	170.22	182.77	195.76	209.20	223.08	237.42	252.19	267.42	283.09	
11/16	86.45	95.46	104.91	114.81	125.15	135.94	147.18	158.86	170.99	183.57	196.59	210.05	223.97	238.33	253.13	268.38	284.08	
3/4	87.00	96.04	105.52	115.44	125.82	136.63	147.90	159.61	171.77	184.37	197.42	210.91	224.85	239.24	254.07	269.35	285.08	
13/16	87.56	96.62	106.13	116.08	126.48	137.32	148.62	160.36	172.54	185.17	198.25	211.77	225.74	240.15	255.01	270.32	286.07	
7/8	88.11	97.20	106.73	116.72	127.14	138.02	149.36	161.10	173.32	185.97	199.08	212.63	226.63	241.07	255.96	271.29	287.07	
15/16	88.66	97.78	107.35	117.35	127.81	138.71	150.06	161.85	174.09	186.78	199.91	213.49	227.51	241.99	256.90	272.27	288.07	

The weights in this table are based on one cubic inch of steel = 0.2833 lb.

For materials other than steel use the multipliers in the accompanying table.

MATERIAL	WT. PER CU. IN.	MULTIPLIER
Wrought iron	0.2779	0.9810
Cast iron	0.2604	0.9191
Yellow brass	0.3029	1.069
Copper	0.3210	1.134
Lead	0.4106	1.449
Aluminum	0.0963	0.3399
Glass	0.0945	0.3338

EXAMPLE: What is the weight of a solid cast iron cylinder, 27 15/16" dia. X 120" long?

SOLUTION: In the table, vertically under 27", and horizontally opposite 15/16, read 166.39 lb

The required weight = 166.39 × .9191 × 120 = 18351 lb.

1 | Aug. 3.05

WESTINGHOUSE ELECTRIC & MFG. CO., PITTSBURG, PA.

87168

FIG. 41. SAMPLE PAGE FROM WESTINGHOUSE BOOK OF STANDARD DATA SHEETS.

magnesium, iron, sodium and potassium, than normally carried by the rivers in the country immediately surrounding, or any liquid possessing an acidity greater than that which would be produced by 20 parts of standard chemically pure hydrochloric acid, to 1,000,000 parts of distilled water. Except in cases where it can be shown that greater quantities of suspended matter or of said salts or a greater degree of acidity does not create damage to natural waters.

(b) Any liquid which contains a greater proportion of arsenic than 0.1 parts in 1,000,000 parts of water.

(c) Any liquid which contains a greater proportion of alkalis or metallic salts other than those herein specified, than 20 parts in 1,000,000 parts of water.

(d) Any substance which becomes putrescible after incubation for one day at 37° C., the index of such putrescibility after such period being an insufficiency in the amount of oxygen free or in organic combination in the incubated sample to combine in stable form with all organic carbon and nitrogen present.

Mr. Geo. A. Soper (New York) presented a paper on "The Role of Public Water Supplies in the Spread of Typhoid Fever, as Shown Chiefly by the Greatest Typhoid Epidemics." Besides brief reviews of epidemics attention was called to other means of spreading typhoid than water, and also to "danger signals" in the form of slight epidemics of diarrhoeal diseases which often precede typhoid outbreaks.

A brief discussion of the four papers already outlined followed their presentation. In response to a request from Mr. Leighton for suggestions as to increasing the usefulness of the hydrographic work of the U. S. Geological Survey, Mr. Dabney H. Maury (Peoria) remarked that the mapping work of the Survey was perhaps the most valuable work the Government has done. The gaging and analyses of streams is good, but has not yet gone far enough to equal in value the mapping work. Quite a lively discussion followed over Mr. Leighton's proposed tolerance of any sewage discharge into a stream used for drinking purposes, Mr. F. A. W. Davis and Mr. Morris Sherrerd (Newark) being opposed to such action. Mr. M. Prenter (Pittsburg), referring to comments on the amount of typhoid in his city, stated that the vital statistics of Pittsburg show that the south side of the city, which is supplied with Monongahela River water by his company, has been relatively free from typhoid, which he attributed to acid mine wastes in the river.

A paper on "Water Softening for Municipal Supplies," accompanied by lantern slides, was read by Mr. Geo. W. Fuller (New York). The general problem was stated, and a number of municipal plants were described, including those at Southampton, England; Winnipeg, Man.; Oberlin, Ohio; Freeport, Ill.; and St. Louis, Mo., and the plant now under construction for Columbus, Ohio, as well as the one proposed for New Orleans.

Under the title, "Copper Sulphate Results," Mr. James M. Caird (Troy, N. Y.) reviewed some of his experiences with this means of fighting algae growths.

"Disinfection as a Means of Water Purification," by Mr. Geo. C. Whipple (New York), related to the treatment of water with copper sulphate, ozone and chlorine. The latter is used at Ostende and Middlekirke, Belgium, "as a disinfecting adjunct to filtration." Mr. Whipple's advance abstract of his paper may be quoted with profit:

The water supply at Ostende, Belgium's noted summer resort, is taken from one of the canals. It is filtered through a mechanical filter of the Howatson type and the effluent is treated with a solution of peroxide of chlorine. This is made by heating together oxalic acid and potassium chlorate, and aspirating the fumes into a chamber partly filled with water. The treated water is kept for a time in a covered basin and is then allowed to flow into an open reservoir, from which it is pumped to the city. The result is said to be satisfactory from the standpoint of bacterial destruction. To be sure the chlorine content of the water is increased somewhat by the process, but as the canal water is brackish in any case, this is not considered an important local matter.

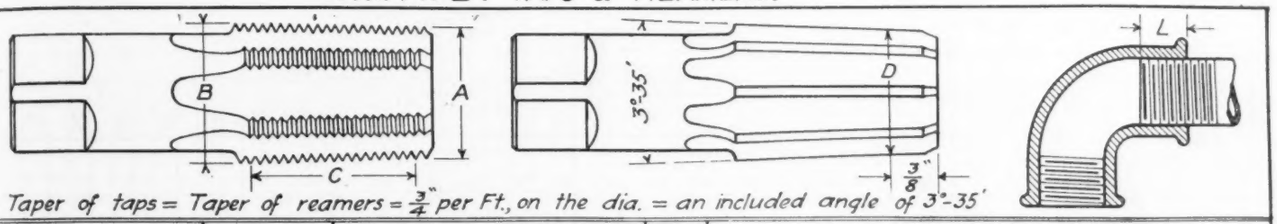
At Middlekirke, another seacoast resort a few miles from Ostende, the so-called ferrochlore process is used. Ferrochlore is the trade name for the product made by mixing solutions of chloride of lime and ferrous sulphate, and which is added to the water as soon as prepared. The reaction results in hypochlorous acid, which acts as a disinfectant. The process is used in connection with a mechanical filter of the Howatson type. The ferrochlore process is looked upon with favor by some well-known European engineers.

A SYMPOSIUM ON THE CHICAGO DRAINAGE CANAL CASE.

The program called for a part of one session and all of another to be devoted to the Chicago drainage canal suit, brought in the United States Supreme Court to prevent the alleged pollution of the water supply of St. Louis by the sewage of Chicago. Only one session was devoted to the subject, the whole of the other session being used up in the election of officers and the choice of the next meeting place—thanks to the cumbersome methods of nominations and balloting still practiced by this association.

The symposium was begun by a brief review of the suit, presented by Prof. Wm. P. Mason (Troy, N. Y.), and was continued by R. S. Weston (Boston), Prof. Gardner S. Williams (Ann

W.I. PIPE: TAPS & REAMERS.



Taper of taps = Taper of reamers = 3/4" per Ft., on the dia. = an included angle of 3°-35'

PIPE DIAMETERS			THREADS		TAP & REAMER				L	PIPE DATA					
Nominal	Actual Inside	Actual Outside	Nbr per INCH	Tap drill Dia.	A	B	C	D 3/8" from end	Approx. GRIP	Thickness of Wall	Internal Area in Sq. In.	Feet length that will just contain one cubic Ft.	Feet length of pipe per sq. Ft. inside Surface	Feet length of pipe per Sq. Ft. outside Surface	Weight in lb. per foot of length
1/8	0.270	0.405	27	21/64	0.370	0.412	11/16	11/32	1/4	0.068	0.057	2513.00	14.151	9.434	0.24
1/4	0.364	0.540	18	29/64	0.478	0.551	1 1/16	7/16	1/4	0.088	0.104	1383.30	10.500	7.075	0.42
3/8	0.494	0.675	18	19/32	0.615	0.679	1	9/16	1/2	0.091	0.191	751.20	7.732	5.658	0.56
1/2	0.623	0.840	14	23/32	0.767	0.846	1 3/8	43/64	1/2	0.109	0.304	472.40	6.132	4.547	0.84
3/4	0.824	1.050	14	15/16	0.977	1.057	1 3/8	57/64	1/2	0.113	0.533	270.00	4.635	3.638	1.12
1	1.048	1.315	11 1/2	1 3/16	1.215	1.321	1 13/16	1 1/8	5/8	0.134	0.861	166.90	3.645	2.904	1.67
1 1/4	1.380	1.660	11 1/2	1 15/32	1.568	1.675	1 7/8	1 7/16	5/8	0.140	1.496	96.25	2.768	2.301	2.24
1 1/2	1.611	1.900	11 1/2	1 23/32	1.853	1.956	1 3/4	1 23/32	5/8	0.145	2.037	70.66	2.353	2.010	2.68
2	2.067	2.375	11 1/2	2 3/16	2.270	2.381	1 13/16	2 3/16	3/4	0.154	3.356	42.91	1.848	1.608	3.61
2 1/2	2.468	2.875	8	2 11/16	2.735	2.910	2 1/2	2 33/64	13/16	0.204	4.780	30.10	1.548	1.329	5.74
3	3.067	3.500	8	3 5/16	3.319	3.557	2 1/2	3 13/64	7/8	0.217	7.383	19.50	1.245	1.091	7.54
3 1/2	3.548	4.000	8	3 13/16						0.226	9.887	14.57	1.077	0.955	9.00
4	4.026	4.500	8	4 5/32						0.237	12.730	11.31	0.949	0.849	10.66
4 1/2	4.508	5.000	8	4 9/32						0.246	15.961	9.02	0.847	0.764	12.49
5	5.045	5.563	8	5 17/64						0.259	19.986	7.20	0.757	0.687	14.50
6	6.065	6.625	8	6 1/4						0.280	28.890	4.98	0.630	0.577	18.76
7	7.023	7.625	8	7 5/16						0.301	38.738	3.72	0.543	0.501	23.27
8	7.982	8.625	8	8 5/16						0.322	50.039	2.88	0.478	0.543	28.18
9	8.937	9.625	8	9 5/16						0.344	62.730	2.29	0.427	0.397	33.70
10	10.819	10.750	8	10 5/16						0.366	78.838	1.82	0.381	0.355	49.00

1 July 11.05

WESTINGHOUSE ELECTRIC & MFG. CO., PITTSBURG, PA.

88090

FIG. 42. SAMPLE PAGE FROM WESTINGHOUSE BOOK OF STANDARD DATA SHEETS.

Arbor), Prof. Leonard P. Kinnicutt (Worcester), Rudolph Hering (New York), G. W. Fuller (New York), Allen Hazen (New York), Geo. C. Whipple (New York) and Elbert E. Lochridge (Springfield, Mass.). In addition printed or typewritten discussions by John W. Hill (Cincinnati), and Profs. E. O. Jordan (Chicago), T. J. Burrill (Urbana, Ill.) and H. L. Russell (Madison, Wis.) were read by title. The plan of the symposium was to have each of the principal technical witnesses in the case abstract his own testimony, but this was not followed throughout. Since an abstract of all the testimony is now in press for publication by the U. S. Geological Survey only a few of the points of the symposium will be noted here, and those chiefly comments on the case, rather than abstracts from the testimony.

Prof. Williams stated that a notable feature of the case was the fact that the attorneys on neither side had had previous experience in a similar case. The bacterial evidence in the case was a failure. Evidence of damage to St. Louis should have been sought in the mortality statistics of that city. The St. Louis attorneys failed to appreciate this fact and consequently those statistics were not properly studied.

Prof. Kinnicutt thought that the study of the Illinois River threw more light on the self-purification of streams than any other study made. It showed that neither extreme view on that subject was correct.

Mr. Hering gave credit to Dr. John Rauch for first recognizing, years ago, the relation between the volume of a stream and the population from which sewage could be discharged into that stream without creating a nuisance.

Mr. Fuller said it was no discourtesy to the legal advisers of Missouri to state that the frequent changes in their membership during the suit handicapped that side of the case, and that it was also handicapped financially.

Mr. Hazen said that at the close of the suit one of the counsel declared that of the 13,669 pages of testimony 69 pages were relevant. Of the total testimony, Mr. Hazen stated, a large proportion were devoted to the typhoid bacillus. The real question was not the distance the typhoid germ can travel in water, as stated by Prof. Jordan, but rather the effect of the germ on the people of St. Louis. Even typhoid statistics alone are insufficient, since it causes not more than one-fourth of the sickness and death due to polluted water. The bacteriologists must broaden their studies, and until they do so they must continue to make assertions instead of submitting definite proof.

Mr. Whipple thought that if the technical experts on both sides of the case could have conferred without the lawyers the testimony would have been less conflicting. The lawyers wanted not only to prove their case but also to prove that they had proved it.

Mr. Lochridge was of the opinion that the proper way to study typhoid and water supply was in connection with the actual users of the water. This, it appears, was not done in St. Louis until near the close of the testimony.

OTHER PAPERS AND DISCUSSIONS.

Many other papers, besides those already named, were presented to the convention, either in full or by title. In fact the papers printed in advance of the meeting made up a total of some 250 octavo pages or more. Mr. Ge... Robertson described an extension of a st... main at Yarmouth, N. S., and a rough and r... method employed to remove incrustations f... a part of the old main. Mr. H. F. Dunham (... York) submitted some notes and diagrams ... the fluctuating levels of the Great Lakes. P... C. H. Hurd took up "Boiler Plant Econom... Chas. A. Hague presented a long paper on "... Growth of the "Pumping Station," and Mr. A... L. Holmes contributed a paper on "Pump S... page." Other papers on the program, some ... which may be noted more fully in a later is... were as follows: "Notes on Comparative E... ciency of Cast Iron and Riveted Pipe," L. J. ... Conte; "Expanding Water Supply Systems," ... T. Fanning; "The Simplex Water Meter," J. ... Ledoux; "A New Hydraulic Unit" ("a circu... inch one foot long"), Prof. D. W. Mead; ... Retrospect of an Arbitration on the Value of ... Water-Works" (city of Baltimore and Baltimo... County Water & Electric Co.), Albert H. Wei... "Protection of Meter Register," C. E. Loetz... "Philadelphia High Pressure Water-Works," ... L. Hand; "Cheesman Dam" (near Denver, Colo.)... George T. Prince; "Metropolitan Water-Works ... (Boston), Dexter Brackett; "Increasing the Ca... pacity of the Hackensack Water Co.'s System b... Introducing a Relay Pumping Station," by D. W... French.

OFFICERS AND PLACE OF MEETING, 1907.

As president for the ensuing year the only nominee was Mr. Dabney H. Maury, M. Am. Soc. C. E., of Peoria, Ill. The five vice-presidents chosen are: Geo. H. Felix, Reading, Pa.; John B. Heim, Madison, Wis.; Alex. Milne, St...

STOCK SIZES OF MACHINE BOLTS.

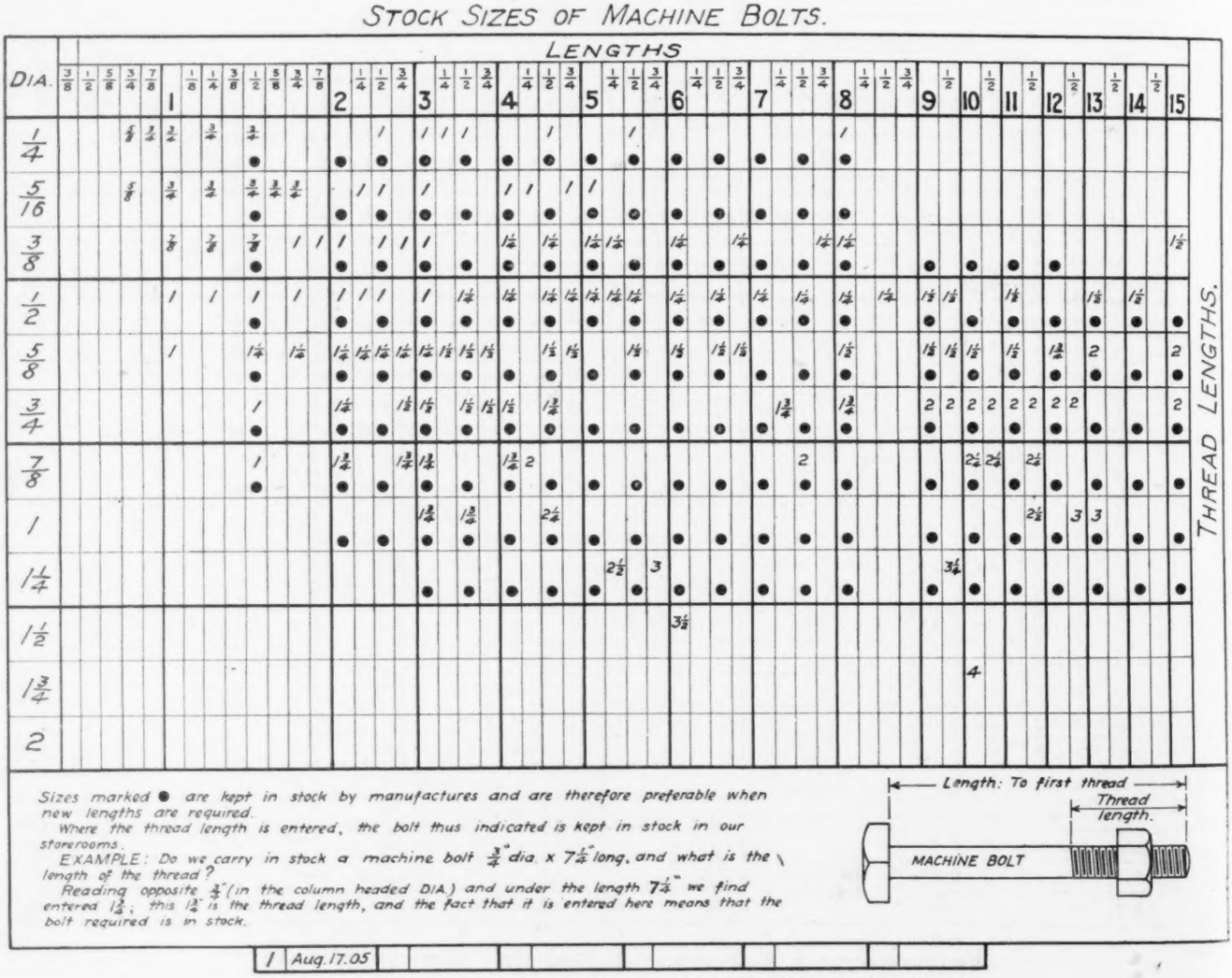

LENGTHS
DIA.
THREAD LENGTHS.
Sizes marked ● are kept in stock by manufactures and are therefore preferable when new lengths are required.
Where the thread length is entered, the bolt thus indicated is kept in stock in our storerooms.
EXAMPLE: Do we carry in stock a machine bolt ¾" dia. x 7¼" long, and what is the length of the thread?
Reading opposite ¾" (in the column headed DIA.) and under the length 7¼" we find entered 1½"; this 1½" is the thread length, and the fact that it is entered here means that the bolt required is in stock.
Length: To first thread
Thread length.
MACHINE BOLT
1 Aug. 17. 05

FIG. 43. SAMPLE PAGE FROM WESTINGHOUSE BOOK OF STANDARD DATA SHEETS.

Catharines, Ont., D. W. French, Hoboken, N. J.; Prof. W. P. Mason, Troy, N. Y. For secretary-treasurer Mr. John M. Diven, Charleston, S. C., was unanimously re-elected.

The candidates for the next meeting place were Milwaukee, Wis., Norfolk, Va., Niagara Falls, N. Y., Toronto, Ont., Atlantic City, N. J., and Put-in-Bay, Ohio. A single ballot decided the question in favor of Toronto, which received 96 out of 147 votes.

In conclusion it may be noted that Mr. James H. Caldwell was chairman of the committee on exhibits, and that Mr. J. A. Tilden was chairman of the entertainment committee, and that both exhibits and entertainment were specially praiseworthy.

SOLID PIER CONSTRUCTION AT BALTIMORE HARBOR.

The Harbor Board of Baltimore, Md., prefers solid construction for the piers for railway freight and steamship service, rather than the ordinary open pile pier construction in general use at harbors in this country. The preference is partly on account of sanitary reasons, since deposits cannot well be removed from beneath the open piers. Piers of both types are in use at Baltimore, and three of the solid piers are now being built; two of these are each 200 ft. wide, with lengths of 614 ft. to 816 ft.; the third is 150 ft. wide and 530 to 573 ft. long. These have masonry walls on pile and timber foundations, with earth filling behind the walls, and the construction is clearly shown in the accompanying cut.

Along the sides and ends of the piers, as well as at the shore bulkheads of the slips between them, are driven five rows of piles; those in the two front rows are spaced 4 ft. c. to c., while those of the other three rows are 8 ft. c. to c. Each row of piles is capped with longitudinal timbers 12 × 12 ins. Transverse tie timbers directly over the piles are laid across the caps and are notched or boxed out over them, while intermediate or jack ties are placed over the alternate pairs of extra piles in the front two rows. A grillage or floor of 2-in. plank is laid across the two front lines of caps, and upon this is a 4-in. concrete filling, flush with the tops of the tie timbers. Upon this is built a wall of coursed rubble masonry. Behind the wall is a flooring of 6 × 12 in. planks laid across the tie timbers, and sheet piling is driven in the rear of the last row of piles and caps. The space between the walls is then filled in level with the tops of the walls, this being done either by dredges or by carts and wagons. The face of the wall is protected by fender timbers, as shown.

The piles are of yellow pine, not less than 12 ins. diameter at the butt (where sawed off) and 8 ins. at the point. They must be driven to depths of not less than 25 ft. to 36 ft. in the different rows, as shown in the cut, "and as much deeper as they can be driven by a 3,000-lb. hammer falling 15 ft. (or its dynamic equivalent)." All other timbering, except in the fender work, is of long-leaf yellow pine. The caps are not drift-bolted, but are secured to the heads of the piles by 1½-in. locust trenails 20 ins. long, split and wedged at the lower end; all scarfs (ship laps) are made over the heads of the piles and are 3 ft. long, each secured with five 1½-in. locust trenails 12 ins. long. All square timbers are secured to each other with similar trenails 12 ins. long for 12-in. timbers and 9 ins. long for 6-in. timbers. Where timbers are notched into each other, half the depth of the notch is taken out of each timber. The concrete for leveling up beneath the masonry wall is composed of 1 part cement, 3 sand and 5 broken stone.

The masonry of the wall is of "first-class, rock-faced, hammer-dressed, ranged rubble," with no projection over 2 ins. beyond neat lines; the seats for oak fenders on the face of the wall must be trimmed to make a fair bearing. The stones are to be of gneiss or granite, each laid on its broadest surface; the beds and builds are hammer-dressed to fair surfaces, and joints dressed at least 8 ins. back from the face. The face stones are to be at least 1½ times the rise of the course, breaking joints by at least 12 ins.; at least 20% of the face area must be headers going entirely through the wall. The stones will be laid with about ⅜-in. joints, well bedded in stiff Portland cement mortar of 1 cement to 3 sand. The backing in the lower courses may have stones not less than 8 ins. high, but in the two top courses the stones must be the full height of the course. The coping is of hammer-dressed stone with dressed joints, and in lengths of not less than 4 ft., secured by iron dowels. After the wall is completed the joints are to be raked out to a depth of ½-in. and pointed with 1 to 1 mortar. For the filling, only clean earth, sand, gravel, shells or brick bats are permitted.

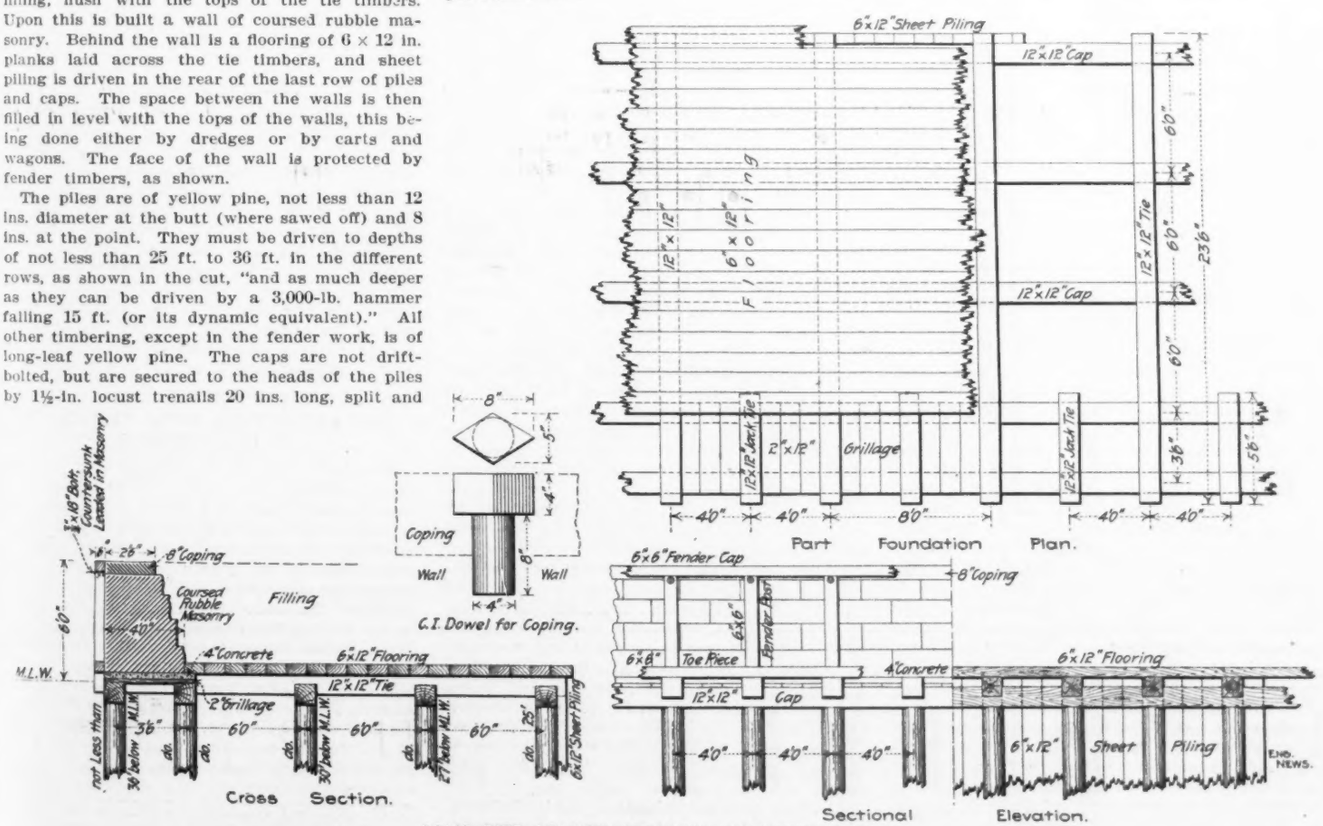
The Degnon Co., of New York, has the contract for the three piers, and we are indebted to Mr. N. H. Hutton, M. Am. Soc. C. E., Harbor Engineer of Baltimore, for information respecting the work. These piers are for receiving and discharging goods from railways or steamships, and will have superstructures or sheds; the superstructures, however, are not provided by the city, but are built by the various lessees to suit their own requirements. All piers are leased at a price per square foot.

LUMBER AND RAILWAY TIE CONSUMPTION IN THE UNITED STATES.

According to statistics prepared by the Forest Service of the U. S. Department of Agriculture, in cooperation with lumber manufacturers, the total amount of lumber cut during 1905 was 27,738,000,000 ft. B. M., of which 23,225,000,000 ft. were from conifers, the balance being hardwoods. This amount was cut by 11,649 firms, but of course there are other firms which did not report. Of the total amount, 10.8% was cut in Washington, 7.3% in Louisiana, 7.2% in Wisconsin, 6.2% in Minnesota, and 6% in Michigan. Yellow pine represented 29.8% of the total; douglas fir, 13%; northern pine, 11.6%; hemlock, 9.3%; spruce, 4% and white oak only 3.9%.

Another set of statistics relates to the consumption of railway ties in 1905, but these are for steam railways only, and do not include the large and increasing consumption for electric railways. The figures are based upon reports from 750 railway companies having an aggregate of 278,262 miles of track, or 95% of the total for the United States. The total number is 80,051,000 (switch ties being figured into the equivalent number of ordinary ties), and 36% of these (or 22,569,000 ties) were for new construction. It is estimated that the total number for the entire railway system was about 84,400,000 ties, representing nearly 3,000,000,000 ft. B. M. The following table shows the different kinds of wood, with their percentages; it also classifies hewed and sawed ties, and it will be seen that the former are by far the more generally used:

Kind.	Cross-ties Purchased, 1905. Number.	Per cent. of total.	Hewed. %	Sawed. %
Oak	38,055,000	47.5	88.1	11.9
Pine	17,496,000	21.9	67.3	32.7
Cedar	6,911,000	8.7	69.3	30.7
Chestnut	4,675,000	5.8	69.5	30.5
Fir	3,485,000	4.4	39.8	60.2
Cypress	3,383,000	4.2	88.9	11.1
Tamarack	3,335,000	4.2	99.0	1.0
Hemlock	1,675,000	2.1	93.4	6.6
All others	1,036,000	1.2	76.0	24.0
Total	80,051,000	100.0	....	....



SOLID PIER CONSTRUCTION IN BALTIMORE HARBOR.
N. H. Hutton, M. Am Soc. C. E., Harbor Engineer.

SIGNALS FOR PROTECTING TRAIN MOVEMENTS AT STATIONS AND WITHIN YARD LIMITS.*

By E. Bignell.†

A large proportion of train wrecks occur at stations, as a result of insufficient protection to trains within yard limits, or insufficient warning to the engineman of an approaching train. For many years targets and lights have been considered to give ample notice as to the position of a switch, but at the present time there are so many switches and so many lights similar to switch lights that confusion is liable to occur. This is especially true of junctions and large yards, where yard engines often occupy the main track and sometimes even use it as a switching lead. The increase in weight and speed of trains makes protection at these points specially necessary, and this is particularly the case where the stations are on sharp curves or at the foot of long, steep grades. Where railways have installed the block-signal system, trains at and passing through stations are properly protected. This is not general, however, while the necessity for protection exists at all stations, and the present paper relates only to methods of protection at stations on lines where the block system is not in use.

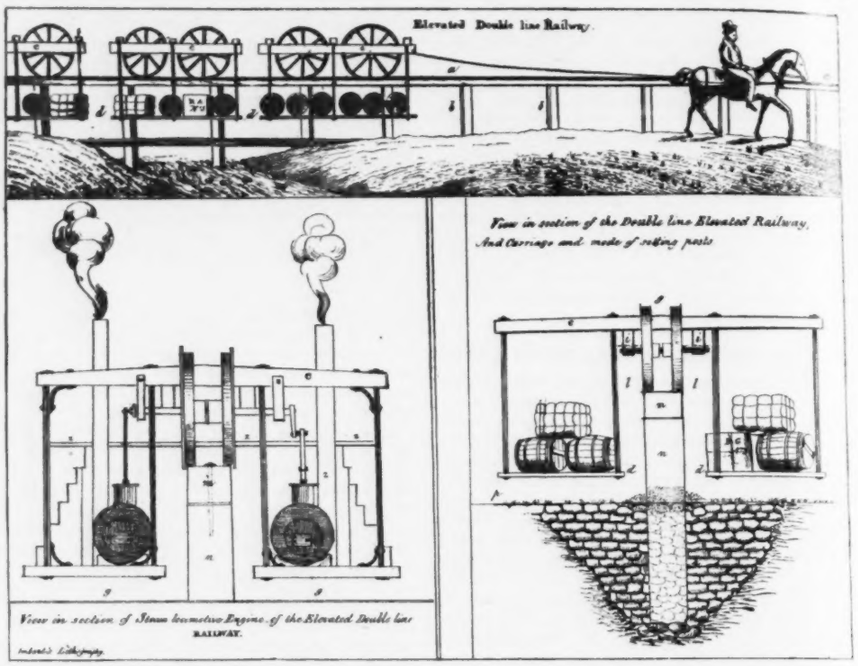
The best means of protection is afforded by semaphore signals (and preferably the automatic electric semaphore), so connected to the switch as to show a danger or "stop" signal when the switch is open or when an engine or car occupies the protected section. Where economy is important, mechanical signals may be practicable at a large number of stations where the view of the signal is unobstructed for a considerable distance. Experience shows that enginemen will sometimes disregard and pass fixed signals. As an additional protection, and to provide against such cases, there should be a derail interlocked with the home signal, as at railway grade crossings. All junction switches and main track crossovers should be interlocked with semaphore signals and derails, and the more dangerous the location the greater is the need of the derail. For the yard service, switching leads should be provided of such length as to allow all switching movements to be made without entering upon the main track. In too many cases, however, the signal department does not receive full cooperation from the operating department. As the latter is held responsible for the safe operation of trains it should be more interested than any other department in the provision of suitable protecting signals. Our members should take up this question vigorously with their respective companies, and the influence of such a movement would be felt very appreciably on those roads which have not now in operation an adequate system of protecting trains at stations and within yard limits by means of fixed signals.

A REMARKABLY GOOD RECORD FOR PAINT applied to a steel structure to preserve it from corrosion was recently uncovered in the course of repairs on the Lawyers' Title Insurance Co.'s Building, 37-39 Liberty St., New York City. The columns of this building rest on plate girders which were painted with Eureka paint. After the building was completed it was found that these girders were submerged in water about 2 ins, and some apprehension was felt as to their durability. This condition continued for about three years, when the water level was lowered and for the last seven years the girders have been practically dry. When these girders were uncovered recently, according to statements made to us by the engineer in charge, the paint was found bright and in first-class condition, and upon scraping the paint off the steel was left clean and showed no trace of corrosion.

A PROPOSED ELEVATED RAILWAY OF 1827.

The elevated double track railway here shown is taken from an old pamphlet issued in 1827 by John Langdon Sullivan, and entitled "A Suggestion of a Plan of uniting Roads with Railways to facilitate and extend the internal commerce of New York."

The author contended that the length of route and the mountainous nature of the ground to be necessarily traversed in this country would make ordinary railways, such as were then being constructed in England, almost prohibitive in cost. He believed that the form of railway best adapted to the climatic and economic conditions of the United States would be one combining the good properties of the English two-rail track with the elevated railway for the suspended car—"which latter originated in America." He said that our turnpike roads had disappointed their builders; and that East and West traffic still preferred the line followed by the Mississippi, the Gulf and the Ocean passage to Eastern ports. As a consequence, "Pennsylvania was building


Elevated Double line Railway.
View in section of the Double line Elevated Railway, And Carriage and mode of rising posts
View in section of Steam locomotive Engine of the Elevated Double line RAILWAY.

AN ELEVATED RAILWAY OF 1827.

her canal, and Maryland her railway." But Mr. Sullivan believed that the railway was only good for a winter route; and added: "It is easy to foresee that if the railway from Baltimore is elevated above the snows of the Allegheny and the mud of the spring months in the lower districts, it will be the sole operative route during the season when the usefulness of the canal is suspended by winter, and before the canal can be put into operation in the spring. The railway may always be the cheapest, if not too expensive in its plan." The author, quoting from "late publications," and in speaking of the bad qualities of American roads, says that the cost of transportation on English roads, all included, is 9 cts. per ton-mile; while "it is well known to be 13 cts. between New York and Philadelphia, and thence to Pittsburg 17 cts." "On the Erie Canal it is 5½ cts. per ton-mile." He then quoted English experiments to show that on railways the transportation cost may be as low as 0.45 cts. per ton-mile.

Mr. Sullivan also quoted authorities to show that the mud on the ordinary railway tracks interfered largely with the adhesion or tractive qualities of the motor, and hence he advocated a railway elevated above the influence of mud and dust. He believed that the elevated double-line railway here shown combined the good qualities of the low railway with two parallel rails, and the elevated single-rail railway which had been suggested for carrying a suspended load. He laid much stress upon the single line of foundations for the two rails; and he suggested stone posts with iron rails alone, made sufficiently strong to span the space. But for cheaper construction, wooden posts and two planks of hard-wood, without iron, would last for a considerable time. He suggested, also, means of preserving the wood by tar, sheet-copper caps, etc.

Sullivan filed his specifications for this elevated railway Dec. 17, 1827, and describes it as shown in the illustration. The foundations were to be stone posts, or wooden posts or piles—according to the money at command and the country traversed. The caps supporting the two lines of strap-iron forming the rails were laid to established grades. The two pairs of flanged wheels support the frame from which the load was suspended; but to facilitate the rounding of curves each wheel was made to revolve independently. To "turn-out," from one track to another, he proposed a section of hinged track, turning on rollers revolving on iron segments: one such hinged segment to come out from each track. The rails on the "turn-outs" were to be curved so as to avoid angles. The inventor did not describe the "steam locomotive engine" illustrated; and only said that it would be cheaper than horse-traction for a line of any length.

This John Langdon Sullivan was then well known as an inventor and civil engineer. He was born in Saco, Me., April 9, 1777, and was a son of James Sullivan, at one time Governor of Massachusetts. After graduating at Harvard he traveled in Europe for several years and made a special study of the canals of France and England. On his return in 1804 he was made Engineer of the Middlesex Canal, running between Boston and Concord. Sullivan invented a steam tow-boat; and in 1814 he obtained a patent for this boat by claiming and apparently proving priority of invention over Robert Fulton. He built a steam vessel after his own designs for use on the southerly coast of the United States, about Savannah; but as a commercial enterprise the attempt was a failure. In 1824, John Langdon Sullivan was appointed by President Monroe an Associate Civil Engineer on the Board of Internal Improvements; but he resigned in the following year, after reporting favorably upon a project for a canal across the Allegheny Mountains. He later took up the practice of medicine in New Haven and New York and made a number of valuable improvements in surgery. He died in Boston, Feb. 9, 1865.

SOME RECENT BLOCK SIGNAL SYSTEMS FOR ELECTRIC RAILWAYS.

The desirability of the introduction of block signal systems on electric railways operating cars at high speeds and frequent intervals was referred to in an editorial article on the safe operation of electric railways in our issue of June 7, and it was shown that the use of such systems on railways of this class is as yet very limited. The elaborate new signal installation on the Electric Zone lines of the New York Central & Hudson River R. R.* furnishes an example of the thorough attention given to the subject in a case of very heavy, fast and important traffic. This case also illustrates the extreme youth of the subject, for, the system of signaling adopted for the New York Central Electric Zone, the Young system, built by the General Railway Signal Co., of Chicago, Ill., was first publ

*Abstract of a paper read at a meeting of the Central Association of Railway Officers, at St. Louis, Mo.

†Superintendent of Lines West of the Missouri River; Chicago, Burlington & Quincy Ry., Lincoln, Neb.

*See "Block and Interlocking Signals in the Electric Zone of the New York Central & Hudson River R. R." Eng. News, June 14, 1906, p. 648.

exhibited less than three years ago.† Particulars of some systems which have been put in service will therefore be of interest.

In the latter part of 1903, the North Shore Ry. running out of Sausalito, Cal., was equipped with alternating-current signals by the Union Switch & Signal Co., Swissvale, Pa. This system has since been adopted on a number of electric elevated and underground railways, as described in our issue of July 13, 1905, p. 32. On the North Shore Ry. there are 30 signals installed on 10 miles of double track, with a single-track section 0.66 mile long extending through a tunnel. An unusual feature is that this part of the road is operated by standard-gage electric cars and narrow-gage trains with steam locomotives. A third-rail conductor is used. An interesting feature of the installation is that the tunnel is lighted by electricity when cars pass through it, the lights being cut in or out by the movement of the signal governing the block section in which the tunnel is located.

The signals are of the semaphore type, operated by storage batteries of small capacity located in a chamber forming the pedestal of the signal post. The batteries are charged, through high resistance, by current from the third rail. Electrical energy of constant potential for the operation of the signals is thus available at all times, although during certain hours of the night the electric service was shut down and only the steam service was continued. Two wires carry alternating current at 2300 volts for the track circuits and for lighting the signal lamps at night. Upon one of the line-wire poles at the advance end of each block section is a transformer, the primaries of which are connected across the wires above mentioned, while the secondaries are connected to the ends of the track circuit. Across the rails at the other ends of the track circuit is connected the track relay which operates inductively to close the local circuit controlling the signal. When a car or train enters the block section, this relay is shunted, opening the signal circuit and causing the signal to go to the "stop" position. There are no primary batteries, and the secondary batteries for the signals require very little attention.

The Boston & Worcester Ry. is one of the important electric railways of New England, and is a double-track line operated on the trolley system. While free from the liability of head collisions, the fact that it runs largely through hilly country (with no extended view ahead of the car) affords ample opportunity for rear collisions, and the management came to the conclusion that a block-signal system to keep the cars apart on double track was urgently needed. The engineers did not find any system on the market which met their requirements, and therefore devised a system of their own, which has proved very successful; this is now being manufactured and installed by the company. Mr. Milan V. Ayres, Electrical Engineer, states that the two principal characteristics are the following: (1) The signal is a long semaphore arm with illuminated spectacle, of about the same dimensions as are usual on steam railways; (2) the signal works positively at any speed of the car, without throwing the trolley off the wire.

In the block signal system of the Eureka Automatic Electric Signal Co., of Tamaqua, Pa., lamp signals are used. These may be operated by a single-wire absolute-block system which admits only one car at a time. Greater flexibility is given, however, by a two-wire permissive-block system which, by means of intermediate signals, protects two or more cars moving in the same direction through the block and displays danger signals to cars approaching the block from the opposite direction. One trouble with trolley-wire signal systems is that the contact maker on the wire is liable to throw the trolley wheel off the wire, especially when the car is traveling at high speed. The contact maker of the Eureka system is one of its special features, and consists of a pair of steel combs, with the teeth facing inward; it is claimed that the teeth are sufficiently flexible to permit the trolley wheel to accomplish its bridging action without jump or jar, even when operating at high speed. The comb on one side is the full length of the device (about 12 ins.), while on the opposite side are two shorter combs, each separately connected with the signal controllers. The signals have incandescent electric lamps, wired in series, with resistance in shunt around them, permitting sufficient current to pass burned out lamps to keep the other lamps lighted. The wiring diagram is shown in Fig. 1, and the following particulars are from the company's description:

When the trolley wheel engages the contact device on entering a block, current passes from the short comb with which the wheel first makes contact through the coils of the magnets, setting the signals to danger, and by an automatic switching device also causes current to pass from the second short comb, when the wheel engages with it, through the same coils. Upon leaving a block at either end, the reverse operation takes place; current from the first short plate engaged by the wheel passes through the coils of the magnets setting the signals to safety, current continuing to pass through the same coils from the second short comb when the wheel engages with it. Normally, the signal circuit of an empty block is grounded at both ends. It includes a series of green lamps distributed along the block and red lamps at the extreme ends of the block, the circuit simply passing through a switch on the base of the controller, but not through the magnet coils. This construction insures the magnets great freedom from lightning, which might follow along the light circuit. As the magnets are only momentarily in connection with the overhead wiring during the short time the trolley wheel passes through the contact-maker, usually only a fraction of a second, the mechanism is in little danger from lightning leading in from the overhead work. A feed wire comes in to the circuit at each end between the red lamp and the first green lamp. These feed wire connections are normally open. The practical advantage of this arrangement is that, the signal circuit being normally dead, no accidental grounding through bad insulation, failing telegraph or telephone wires, etc., can energize the circuit and cause false signals. Upon entering a block, the current supplied from the contact-maker operates the controller at that end of the block, cutting the ground out and the feed connections in at that end of the block. This causes all the green lights to glow and also the red light at the far end of the block.

As a car passes along the block section, the green lights of the intermediate blocks or subdivisions show that these subdivisions are clear, while the red light at the advance end of the block shows the motorman of an opposing car that the block is occupied by a car approaching him. If a second car follows the first, the green light and the absence of a red light at the entrance of the block show the motorman that a car is ahead of him, and if he has instructions to follow the car he enters the block, but with his car under control. The entrance of this second car does not affect the signals, but moves the circuit controller a notch further. As the first car reaches the end of the block, a red light indicates to the motorman that a car is following him in the block. When a car passes out of the block, the passage of the trolley wheel over the contact-maker sets back the controller at the entering end of the block. If it was the only car in the block (or the last car of two or more), it cuts out all the lamps and leaves the block clear; if there are other cars in the block, however, the first car passing out sets the controller back one notch, but does not put out the lights. If an opposing car passes a red signal and enters a block without waiting for the car approaching to pass out, it cuts out both grounds and extinguishes all lamps. This notifies the motorman of the car having the right-of-way that an opposing car has entered the block in defiance of the signals, and that he must protect himself. Should the trespassing car back out, however, the signal system returns to its normal condition. The following are the principal rules to be observed: (1) In approaching a block section, (A) if no light shows, enter at will; (B) if a green light shows, enter under control; (C) if a red light shows, do not enter. (2) Back out if lamps fail to light on entering a block. (3) Proceed with extreme caution if lights go out while the car is in the block. (4) Look out for following cars if a red light shows on leaving the block.

The system above decribed is in use on several railways, sometimes for lines in open country, and sometimes for isolated blocks with junctions, etc., in city streets, to govern the safe movement of the cars for the various routes. One of the latter installations is shown by the plan in Fig. 2; this is on the Altoona & Logan Valley Electric Ry., at Altoona, Pa., and the following is a description of the operation: The signals are located on 11th Ave., between 16th and Bridge Sts., at a point where the service is complicated and very frequent, and where buildings shut off the view around the corners, as shown by the plan. The Broad Ave. cars and the Hollidaysburg cars, on 8 and 15-minute schedules, respectively, come on Union Ave., up 16th St., and after passing round a loop, come back over 11th Ave. The 7th Ave. cars, on an 8-minute schedule, come in on Bridge St. (at the end of the double track), pass up 16th St., and similarly

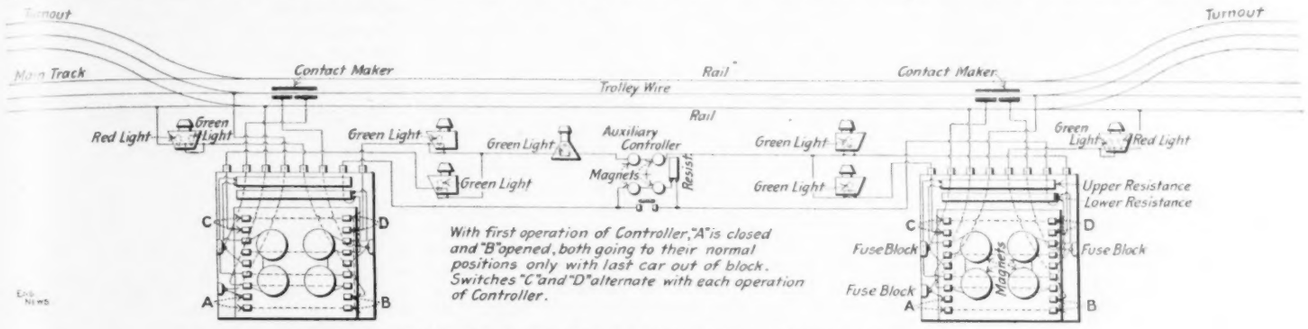


FIG. 1. DIAGRAM OF WIRING FOR THE EUREKA BLOCK SIGNAL SYSTEM FOR ELECTRIC RAILWAYS.
Eureka Automatic Electric Signal Co., Tamaqua, Pa.

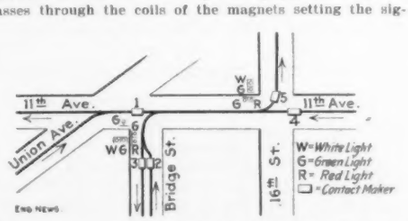


Fig. 2. Plan of Junctions with Block Signals at Altoona, Pa.; Altoona & Logan Valley Electric Ry.

† See an article "A Track Circuit Block Signal for Electric Railways," Eng. News, Dec. 24, 1903, p. 571.

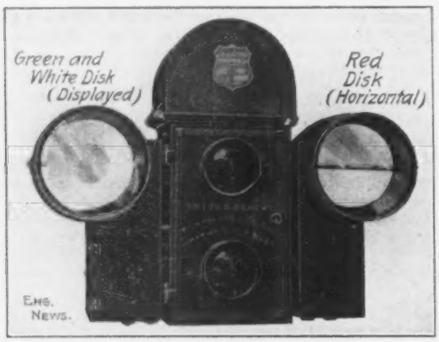


Fig. 3. Block Signal (with Lamp and Disk) for Electric Railways.

United States Electric Signal Co., West Newton, Mass.

return down 11th Ave. and out along Bridge St. The 8th Ave. and Juniata cars, both on 8-minute schedules, also pass over this section in opposite directions on a belt line; the former come in on Bridge St. and up 16th St., while the latter go out by 11th Ave. and Bridge St. Besides this regular service, three or four extra cars may pass over this block at various times during the day. Under such service three or four cars are often in the block at the same time, while as many may be waiting to pass in the opposite direction.

The circuit makers are located as shown by the numbers on the plan. At the end of the double track on Bridge St., and on the corner of 16th St. and 11th Ave. are the governing colored lights, white, green and red, facing outward from the block; and on the corner of 11th Ave. and Bridge St. is an intermediate green light that can be seen from each direction on 11th Ave.

A car entering the block at either Bridge St. or Union Ave. gets a white light at the end of Bridge St. and as it crosses the contact-makers Nos. 1 or 2. In series with this white light are four others: the intermediate light, a green light facing inward at 16th St., and a red and green facing outward against cars coming out of 11th Ave. Successive cars entering the same direction simply alternate the white and green lights at the entering end, while all others remain burning, and remain so until the last car has passed out under No. 5, or under any of the contact-makers. Similarly, cars entering at 11th Ave. and 16th St. under No. 4 get white or green at that end, the intermediate light, the green facing inward, and the red and green facing outward against cars coming in at Bridge St. A car coming in at Union Ave. cannot see the red light at its end of the block, but sees the intermediate light burning. It can cautiously proceed to the corner far enough to see along 11th Ave. and Bridge St. before touching No. 1, and cars in the block can be located. In a like manner the lights remain burning until all cars have passed out under Nos. 2 or 3 or any other contact-maker. Before this plant was installed, it was necessary for conductors to leave their cars and flag their motormen around the corner. As the service here is frequent and street traffic heavy, much annoyance has been saved.

This railway has 16 other similar sets distributed over the system between turnouts on single track, all having the capacity of recording 24 cars in a block. The Schenectady Ry., at Schenectady, N. Y., has 8,750 ft. of continuous track equipped with block signals inside the city limits, where cars are obliged to run in both directions on single track, and where the time intervals between cars vary from 3½ to 7½ minutes. The signals are of the Eureka and United States makes, but the latter permits only one car to pass through at a time, while the former permits cars to go through as sections, as already described. The Eureka company is also perfecting a block system, in which semaphores are used instead of lamps.

The system of the United States Electric Signal Co., of West Newton, Mass., uses lamp signals, in combination with which may be enclosed disks, as shown in Fig. 3; each disk revolves on a horizontal transverse axis passing through its center. At each end of the block section is a signal box (Fig. 3) and an automatic trolley switch, the former being placed about 100 ft. ahead of the latter so as to be easily seen by the motorman as his car passes under the switch. As the car passes, its trolley wheel operates the switch; this causes a green (or white) disk and light to be displayed at the signal box, and a red disk and light at the box at the other end of the block section, thus warning an opposing car that the block is occupied. A red signal always indicates an approaching car, and a green (or white) signal indicates a receding car; when the block is clear, a green (or white) signal is shown directly the car passes the trolley switch. Should the lamps burn out, the disks remain displayed, but even if the disks are not used, it is still impossible to get a clear signal to enter the block from either end, on account of the relay being mechanically locked by a device which holds the operating lever in the closed position until released by a car passing out of the block. The failure of current on the trolley wire only puts out the lights until the current returns. The signal lamps have 5-in. lenses and are lighted by ordinary incandescent lamps of 16 c. p., 110 to 120 volts. Where cars pass the turnouts at speeds of over 15 miles an hour a special form of trolley switch is used which is operated by the upward pressure of the trolley wheel upon the wire and has no tendency to throw the wheel off the wire.

The diagram in Fig. 4 shows the wiring system, and the position of the apparatus with a car in the block. When the car passed the trolley switch, its trolley wheel closed the right-hand contacts of the switch for an instant, allowing the current to flow over the circuit represented by the heavy dashes, through the magnet A and over line wire No. 3 through the other signal to the ground. The path taken is shown by the heavy full line. The magnet A, upon being energized, throws over its contact lever, disconnecting the ground at this (the setting) end, and cutting in a permanent feed from the trolley wire to take the place of the switch contact, which opens immediately after the car passes. This permanent feed also throws the green lamp and disk into the signaling circuit and their appearance indicates that the red signal is displayed at the opposite end of the block. The other set of contacts closed by this magnet completes a circuit which starts in the outside contacts of both trolley switches. It will be seen by the diagram that the signaling circuit leads through magnet B^1 at the other end, opening a pair of contacts known as the non-interference device. These contacts open the setting circuit from the trolley switch and prevent a car following to enter from the opposite end, locking the lever to magnet A^1, which would connect both ends of the signaling circuit to the trolley wire, making a dead signal until some car passes out of the block. The circuit indicated by light dashes is known as the releasing circuit. When the car leaves the block, going in the direction shown by the wheel, it closes the right-hand contacts in the right-hand switch, thus allowing current to flow through magnet C^1, which breaks the main signaling circuit, and also through magnet B, which unlocks the lever of magnet A. The magnet A, now being de-energized and the lock open, allows the lever to fall back and the system to return to its normal position with no car in the block.

This system is used by the Schenectady Ry. Co., as already mentioned, and also by the Elmira Water, Light & Ry. Co. The latter is using it on the following single track routes: Water St. line, 3½ miles, with cars running at intervals of 15 minutes; Elmira Heights line, 4 miles, 15 minutes; Horseheads line, 6 miles, 30 minutes. It is also being installed on the Watkins line, 22 miles, the signals being placed at each switch with an average distance of 2½ miles between signals. Mr. Wm. W. Cole, Vice-President and General Manager, states that where high-speed service with cars at short intervals is operated on an interurban line he considers the block-signal system as an additional aid in the handling of cars; he considers that it should not take the place of a dispatching system, but should be used only in connection with such a system.

In a block-signal system now being put on the market by the United Electric Signal Co., of Providence, R. I., and intended specially for single-track electric railways, a box at each end of the block section has a large lens with a red disk moving behind it, the disk having a red bull's-eye in the center. In the upper part of the box is a smaller opening which shows a green light when the "stop" signal is displayed at the opposite end of the block. When a car enters the block section, the red target falls in front of the opening in the box or case at the far end of that section, and in so doing establishes a circuit which causes the green light to show at the box which the car has just passed. If a car approaches a block section and finds only a white light displayed, this indicates that the block is clear; a small green light above the white indicates that a car is in the block, but going in the same direction, so that the following car enters the block under control, if so ordered. A large red light, however, indicates that the block is occupied by an opposing car, and the other car must therefore wait on the siding. The last car leaving the block extinguishes the green light at the entering end and returns the red light at the leaving end to the normal white light.

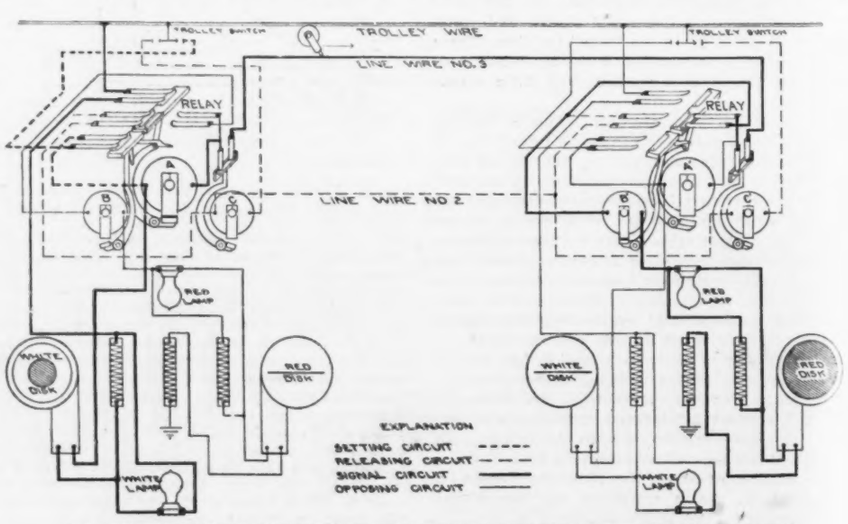


FIG. 4. DIAGRAM OF WIRING FOR THE UNITED STATES BLOCK SIGNAL SYSTEM.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.
220 BROADWAY, NEW YORK

BRANCH OFFICES
CHICAGO: 1636 Monadnock Block
WASHINGTON, D. C.: Home Life Building
ATLANTA: Austell Building
RUDOLF MOSSE, BERLIN AND HAMBURG, GERMANY

SUBSCRIPTIONS

United States and Possessions, Canada, Mexico and Cuba, One Year, $5.00.
Foreign Countries, Regular (Thick Paper) Edition, One Year, $9.00. (£1-18-0.)
Foreign Countries, Thin Paper Edition (Construction News Supplement Omitted), $5.00. 21 Shillings, 25 Francs or 21 Marks. Remit directly to our office.
Pay no money to canvassers for subscriptions.
Remit by Post-Office or Express Money Order, Draft on New York or London, or by Registered Letter.
Notice of change of address should reach us one week in advance of removal. The old as well as the new address should be sent.
Subscriptions cannot be dated to commence with past issues. All subscriptions commence with current issue and back numbers can be supplied only by special order.
Receipts for Subscriptions will not be sent unless requested, the changing of the expiration number being considered sufficient. The number on the address label indicates when subscription expires, the last figure indicating the year, and the one or two preceding figures the week of that year. 52-5 means the 52d week or December 28, 1905.

ADVERTISING

"Contract": Rates furnished on application.
"For Sale": $1.50 per inch.
"Proposal": $2.40 per inch.
"Want": See "Want" Pages

Copy for regular, or "Contract," Advertisements should be received one week before publication. "For Sale" and "Situations Wanted" Advertisements by Tuesday, and "Proposal" and "Situations Open" Advertisements by 11 A. M. Wednesday.

Entered at the New York Post-Office as Second-Class Matter.

We recently received a press bulletin sent out by a well-known University and, we presume, distributed generally to the newspaper press in the region from which the University draws its students. We print the opening lines of the bulletin, omitting only the names, as follows:

STATE UNIVERSITY GRADUATES GET PLACES IN VARIOUS PARTS OF COUNTRY.

. . . . . July 7.—The demand for engineers is well illustrated by the fact that all the students who were graduated from the college of engineering of the . . . . . of . . . . . had secured positions before the close of the university year. So great was the demand this year that many of the students had two and three places open to them, between which to choose. All of the largest engineering companies in the country sent representatives to . . . . . to secure all available graduates.

The conditions set forth in this bulletin are not peculiar to this institution. According to the information furnished us, some of the best known engineering schools had applications for two or three times as many men as they graduated; moreover, the size of the graduating class this year in most institutions was far in advance of all previous records.

On the face of things, therefore, the University is justified in spreading abroad the announcement that the men who have taken its courses and on whom it has placed its hall-mark are in active demand among employers. That this will tend to further increase the number of students seeking the engineering schools goes without saying. Time was, and not long ago, when the college graduate after he stepped off the commencement stage found that the world had forgotten him while he was pursuing a scholastic life and realized no need for his services. The fact that places seek the engineering graduate to-day, while his brother with an A. B. degree is even in these prosperous times obliged to seek for a job is doubtless one of the principal reasons for the astonishing growth of the engineering colleges, in comparison with the colleges of arts.

But the question which appeals to us, and which we believe deserves most careful examination, is to what extent these applications for engineering graduates really reflect a bona-fide demand for engineers—a demand, we mean, that is backed up with the ability and willingness to pay liberal salaries for efficient and responsible work. A great number of young men are starting into engineering courses to-day for no better reason than the certainty of a job at graduation. It is important for them to know not only what the chances are of employment at living wages at the start, but what income may they reasonably expect after accumulating five or ten years of practical experience.

It is our impression that the men in this grade—the rank and file of the profession—have not experienced increase of salaries and increase of demand for their services in these years of engineering prosperity to any such extent as have the men at the top, or the men at the bottom rung of the professional ladder. If we are wrong in this matter, we shall be glad to be corrected. Of course, it is true that the engineer of any grade finds it far easier to find work and there is less tendency to screw salaries to a low notch than was the case during the '90's. Our only claim is that the student who gages the relations of supply and demand among engineers solely by the University announcement quoted above is likely to form some erroneous ideas and be disappointed and disillusioned at some later day.

It may be worth while to refer to some of the conditions under which these applications for men are made. First, as we pointed out in this place some time ago, it is the rule rather than the exception for a man who has a position to fill to send a statement of his wants to two or more colleges and often to half a dozen, or even a larger list. When it is said, therefore, that a college could have placed two or three times as many graduates if it had had them, it does not at all follow that if there had been in the whole country two or three times as many engineering graduates, they could all have found positions.

Analyzing now these applications for men a little further, we find that in a large proportion of them the pay offered is very low and the offer of promotion is held out when the graduate gains experience and demonstrates his ability. No objection can be found to this offer on its face, for the services of the average engineering graduate are not worth any large salary. The only question to raise is as to the employer's attitude of mind. If he is taking the young graduate into his employment with the intention of raising his salary as he becomes worth it, well and good. There is reason to believe, however, that not a few applications sent to the colleges for men, really have behind them the desire to secure technical assistance at low cost. A man who will not go into the market and pay the price a good engineer's or chemist's services are worth, will write to colleges in the hope of getting his work done at a cheap rate. We may remark parenthetically that employers who put responsible testing or investigation work into the hands of green men just out of the schools, in order to save money, are apt in the end to pay dearly for their attempt at economy. It is from men who make experiments of this sort in the employment of college graduates that criticisms are frequently heard as to the training which the college gives its students!

Again, there is a continuous demand for men with executive ability, competent to manage men, to direct work, to organize enterprises. It is in the hope of securing such men that many employers are writing to the colleges. This action is in no way to be criticised. Such opportunities are just what the ambitious young engineering graduate, with proper self-reliance and confidence in his own powers eagerly welcomes. Yet in a very large percentage of cases, we fear, both the employer and the engineer are disappointed. The fact may as well be faced that only a few out of the many graduates from the engineering schools are likely to develop, even after years of experience, the executive ability fitting them for positions of high responsibility.

This is nothing to be wondered at. In fact it would be strange were it otherwise. The qualities which make one a leader of men are inborn. The schools can develop and foster these qualities but they cannot create them. Take any hundred men of good education and place the entire responsibility for the success of a dangerous and difficult enterprise upon each of the hundred in succession. It will be found that probably 50 to 75 will make a flat failure of the enterprise and will declare that circumstances were too strong for them. Perhaps 20 to 40 more will achieve something in the way of partial success. Out of the entire hundred, we may expect that only a half dozen, more or less, will possess the courage, tenacity of purpose, industry, and power to bend other men to their own wills, all of which combined make possible the achievement of final and complete success.

It is in the hope of finding some such prize that many employers are giving opportunities to the young graduates from the engineering schools, and the movement is in every way to be commended. We only wish to point out here that there is no need for them to be disappointed, even though only an exceptional graduate measures up to a high standard in executive ability.

In the development of underground rapid-transit facilities, especially those which are to provide for ordinary street car traffic, the present trend of opinion is strongly in favor of the high-level or shallow subway system, with the minimum possible distance from the street level to the station platforms and with the street paving carried directly above the roof of the subway. This system has been recently adopted in London (as described in our issue of July 12), although the numerous "tube" railways which have been built in that city during the past ten years are all deep or low-level lines. The subway system for the street railway lines in the congested business district of Chicago, as proposed by Mr. Bion J. Arnold, consulting engineer to the Council Committee on Local Transportation, comprises an interesting arrangement of high-level and low-level subways in order to avoid the interference of cars running north and south with those running east and west. In the lower lines the depth will presumably be only that necessary to clear the upper lines. The high-level system is adopted for the proposed lines entering the business district from the south side, and having no river to cross. At the north end an incline would afford connection with the tunnel under the Chicago River at La Salle St., thus giving access to the subway for the "north side" cars using the tunnel. Probably most of our readers know that the business district of Chicago is cut off from the north and west sides of the city by the Chicago River, and while several lines cross the numerous bridges, others converge at three tunnels under the river. These tunnels have approach inclines with grades of 5 to 10%, and are about to be lowered in order to give a greater depth of water in the river. The north-side tunnel at La Salle St. is to be connected with the high-level system, as already noted, and this will enable cars to be run through from north to south, and so avoid the congestion due to present arrangement of terminating all lines by loops through the streets of the business district. The two other tunnels, however, handle the traffic to and from the west side, and it is proposed to extend and connect these by deep level subways forming an extended loop serving the business district but avoiding all grade crossings with the north and south lines. As the city fronts on the lake, the west side cars naturally terminate their routes in the business district and then return, but the proposed arrangement provides for such connections that cars entering by one tunnel can pass around the loop and then leave by the same or the other tunnel, thus giving greater flexibility for the routing of cars. This arrangement also fits in very well with the present tunnel situation. It will be seen, therefore, that under this plan the business district would have direct or through lines of high-level subways for the cars running north and south, and a low-level terminal loop for cars running east and west. Inclined connections between the two systems could be provided to enable cars to be run through the west side and north side, or between the west side and south side dis-

tricts, but the conditions of traffic are not such as to render such a routing of cars necessary at this time.

Competitive contract-letting is governed by a definite and strict code of rules, none the less valid because gross breaches frequently occur. Near the head of this code stands the commandment: "Contracts shall be let to the lowest bidder," and not far away is the rule: "After the opening of bids, no bid may be modified in any particular, and no offer to reduce a bid may be accepted." The necessity for both these provisions is fundamental; competitive bidding cannot long exist without them.

A glaring violation of both principles is contained in the action of the Secretary of the Navy, last week, in awarding contracts for armor-plate for two new war-vessels. One of three bidders was considerably lower than the others, and his technical and financial responsibility was not questioned; yet this bidder was awarded a contract for but half the material bid for, and the other half was awarded to the two unsuccessful bidders *on a figure equal to the lowest bid*, according to *a proposition which they submitted after the opening of their bids* showed them to be high. It is not known whether the lowest bidder was also given an opportunity to reduce his bid on the second half of the contract, but the news despatches indicate that the matter was arranged without his knowledge or consent.

A contract for armor-plate differs greatly from a contract for boiler-plate or one for pine lumber. The last is strongly competitive; the second, reasonably so. Armor-plate on the contrary has until the past year been made by but two steel-works in the United States, which are well understood to have had an understanding as to bidding; it requires a very expensive plant for its production, and both the product and the plant are wholly dependent on government contracts. Moreover, the manufacture of the best armor-plate involves the use of secret processes, which further restricts competition. It follows that the case of armor-plate is a very special case of contract-letting, and that as it is not strictly competitive, the ordinary principles of competitive letting are not necessarily applicable.

The case is of interest to all persons [especially engineers] who are concerned in contract letting, because of the obvious danger that it may be interpreted and cited as a precedent for the violation of the usual rules governing contract awards. It is the purpose of this note to emphasize the fact that the case is highly exceptional, and that it sets no precedent valid for citation in the case of ordinary contracts. The exceptional factors are: 1. The case concerns national defence, a matter of superlative importance; 2. The use of proprietary processes is practically unavoidable, and, therefore, the nurturing of these processes for securing an effective instrument of national defence requires consideration; 3. The size of the required plant, and the limited amount of work available, which work must all come from the government, makes competition an economic folly, provided other means of reasonable efficiency for getting the product are available. These are factors which in all probability will never affect contracts for ordinary engineering work.

Notwithstanding the exceptional character of this contract, we would not be understood as approving of the award finally made. So long as the Government pretends or attempts to secure competition in the purchase of armor-plate, it ought to scrupulously observe the code which governs such competition.

CEMENT PRODUCTION IN THE WEST.

In our issue of May 3 we reprinted part of a bulletin of the U. S. Reclamation Service relating to the supply of cement for its various works. In this bulletin it was stated that the Service was experiencing much difficulty in obtaining cement, and the establishment of additional cement mills in the far West was urged. In commenting on this we called attention to the great amount of railway construction and the rapid growth of cities in the far West and approved the idea that opportunities for profitable cement manufacture were to be found on the Pacific Coast.

While this was really the main purpose of the bulletin, and of our comment, the bulletin contained some statements to which the manufacturers of Portland cement have taken decided exception. One well-known cement maker sent a circular letter to all the principal cement mills in the West reading substantially as follows:

Sir: In Engineering News of May 3 is an editorial, quoting from a bulletin issued by Reclamation Service, stating that, almost without exception, Government requests for bids on cement are turned down. Eight manufacturers of cement were recently asked for bids on 2,000 bbls. with only one bidder, and the price was too high. On another occasion, for several thousand barrels, 23 parties were asked, with only one bidder. The article goes on to state that the Government is making hundreds of barrels of cement daily at the Roosevelt Dam, near Phoenix, Ariz., below the market price. The writer has personal knowledge of conditions at Phoenix, and I have good reason to believe that this is not so, and believe that the object of this bulletin is to pave the way to urge the Secretary of the Interior to permit other cement mills being constructed by the Government.

With a view of getting information on this subject, I write to ask whether you were asked to bid on these jobs, if so, did you refuse? If not, would you object to telling me what you quoted them, f. o. b. mill? Did you not have plenty of cement in stock during past five months to fill such orders as these, if the conditions required by the Reclamation Service were equitable and the price they were willing to pay reasonable? What was the daily capacity of your plant during the past six months?

By the courtesy of the cement maker referred to, the replies to this circular letter have been placed in our hands, and we present the following extracts from them, omitting the names of the writers:

We have invariably bid on every job we have been asked to bid upon, and every job that we saw any possibility of getting, whether asked to bid or not. We omitted to bid only when the freight rates were most decidedly against us, as at Yuma, California, and Belle Fourche; we even bid on cement for Oregon. We are filling all our contracts with them just as fast as the cement is asked for. We expect to bid on all Reclamation work in our territory and supply all the cement they contract for. It is really worth a great deal more to handle Reclamation Service contracts than the general market, but they have been getting market prices and should be satisfied.

The capacity of our plant is now 1,400 barrels per day. It will be 2,500 barrels by August next.

For your information, will say that we have been furnishing for the last three years, all of the cement required for reclamation work in Nevada and California.

Most of the cement furnished the Government has been sold at $1.50 f. o. b. the car our works, not including sacks. However, in asking for bids on the Klamath project the terms of payment were such that we added 5 cts. per barrel, and took the order at $1.55, f. o. b. works.

We did not quote on the job in question, mainly because the Government is not willing to buy cement under the same rules and regulations as we sell the trade in general. They often fail to tell us where the cement is going to be used. They have restrictions as to package, etc.; and they frequently get matters in their specifications that are not acceptable to us. If the Government will confine itself to standard specifications, comply with our regulations as to payment for sacks, etc., we shall only be too pleased to quote them from time to time, but we do not see any reason why we should favor the Government as against our regular trade. In other words, we believe in a "square deal" to all purchasers.

During the past year our output has been 2,000 barrels per day. We will start our . . . . plant next month, which will give us a combined output of 5,000 barrels per day. In addition to this the writer owns a controlling interest in the . . . . . Company, with a capacity of 1,800 barrels per day.

This company has annually furnished the U. S. Government with a great many thousand barrels of cement for use under supervision of engineers of the Army or Navy, as, for instance, during 1905 we furnished cement on contracts aggregating over 250,000 barrels.

Very naturally we have from time to time received invitations to bid for the work being done by the U. S. Reclamation Service, but because of certain provisions of the specifications covering the Portland cement used in this work we have been unable to enter bids.

The main points to which we objected were as follows:

In the paragraph on composition—"But in certain cases where such amounts of these substances are objectionable, the engineer in charge of the work may specify lower percentages." This, of course, places the manufacturer entirely at the mercy of the engineer, who is thus empowered to eliminate any cement at any time he may desire, and whose judgment is final. We would not, of course, care to take a contract where the engineer might at his option change the chemical analysis to an extent that would necessitate our either changing the standard analysis of our product or defaulting on the contract.

Paragraph on factory inspection.—This is objectionable as well as the paragraph regarding the sampling. We could not allow representatives of the Government access to and the freedom of our laboratories, although we would furnish them accommodations for making any tests or experiments desired. Neither could we allow them to seal bins after samples had been drawn, or to store cement until results of tests had been determined. These things would interfere too much with our regular routine and the business, while very satisfactory, would be relatively of insignificant volume.

Our letters possibly had some effect as in successive advertisements these specifications have been considerably modified.

Some exception could be taken to the price allowed for cloth sacks not returned, which is 10 cts. as against 7½ cts., the customary figure, and the requirements regarding percentage of increase in strength. Cement people know that it is difficult for rotary kiln cement to show an increase of 15% from the 7 to the 28-day period, this being due not to any inferiority of the product, but to the fact that the cement is more finely ground and contains no underburned material, and therefore obtains very nearly its final strength at an early period. The whole question of increase in strength in modern Portland cement is one of hardening, and we do not think any well made rotary kiln Portland cement should be expected to meet a 15% increase unless the briquettes are manipulated or "jockeyed" in such a way as to produce that result.

In conclusion allow us to say that we know of no combination or agreement among the manufacturers to "hold up" the Reclamation Service for its Portland cement requirements either through asking for exorbitant prices or refusing to enter bids.

I have noted the editorial in the Engineering News on the extract from bulletin issued by the Reclamation Service in regard to shortage of Portland cement in the West. There is no doubt that there is a serious shortage of Portland cement in the far West. Aside from the actual difficulty of anybody in purchasing cement in the Western states, the Reclamation Service receives very few bids on account of difficulty in meeting their specifications in the matter of quality, and also the numerous unbusinesslike requirements in the matter of bids, return of sacks, etc. If they would purchase cement in the same way that a railroad does, or other private parties, they would get more bids and lower prices. They should pay for the sacks with the cement, pay freight for returned sacks, they should more closely specify quantity and time of delivery, and in a number of ways conform more closely to commercial custom in the cement business.

I do not remember that we have ever declined to make a price f. o. b. our mill on any Reclamation work when requested for price, and we have sold the Reclamation Service a total of about 75,000 barrels.

We have never had any difficulty with furnishing them cement according to their specifications; in fact, we have never had a barrel rejected, although many of the Western mills have difficulty in keeping their sulphuric acid down to requirements of the specifications.

To my mind, it would be foolish for the Government to go into the cement business any more than it has done, as it cannot afford to erect a mill for the sake of a few hundred thousand barrels and then throw the mill away. They seem to think that they are the only ones that are having difficulty in getting cement at low prices, whereas every user, railroad or contractor, is having the same difficulty, and the result will be that private enterprise will build more plants automatically to take care of the demand; in fact, we are going ahead as fast as we can to add 10,000 barrels to our capacity.

The worst thing about the cement situation is that a good many people are getting the idea that there is a cement trust, whereas it is absolutely an open and natural market, and the only thing putting the prices up is the excess of the demand over the supply.

The Government has a little single rotary water-power cement plant located on Salt Creek, in Arizona, wherein they are manufacturing cement for the erection of a dam on account of the Reclamation Department of the United States Government. This dam is built about fifty miles from the railroad and immediately at the dam site there was water-power enough to operate a small mill of one

kiln. Owing to the distance from the railroad, and in consequence the heavy teaming charges on Portland cement from the railroad to the dam site, it, of course, put the price of Portland cement up very high. This, taken into consideration with the water power at the dam site, puts the whole proposition clearly before you.

In our opinion the only reason that the Western manufacturers of Portland cement do not bid on this work is by reason of the vast amount of red tape and extra expense and out-of-the-ordinary specifications that the Government desires. We are manufacturing our product to conform to the standard specifications adopted by the American Society of Civil Engineers, the American Society for the Testing of Materials and approved by the American Society of Portland Cement Manufacturers, yet on these Government specifications for this reclamation work they vary greatly from these standard specifications.

We have been asked to bid on this work, but have not done so from the very fact that we can dispose of our 6,000 barrels a day elsewhere at better prices and with less trouble and expense. There is no time during the past five months that we did not have plenty of cement in stock to take care of all of this business if the conditions required by the Reclamation Service were equitable and the price they were willing to pay reasonable.

It is true that during this year we have at times received proposal blanks for bidding on cement for Government work, but we refrained from bidding, not because we did not want to make tenders, but because the forward engagements for our present limited output of 2,000 barrels per day made it inadvisable to figure on outside business.

By July 1st, however, our capacity will be increased to 3,000 barrels per day, and our supply will be further augmented by the completion of the new factory at . . . . which will yield 6,000 barrels from Dec. 1, and an additional 6,000 barrels after May 1, 1907.

In our judgment there is absolutely nothing in this complaint as to the failure of cement makers to supply the Government Reclamation Service. Of course, all the Western plants are just at present oversold, and have been for the past six or eight months, and under the circumstances they are not able to supply the Government requirements, and therefore to not make bids. They are, however, at the same time turning down business for individuals and corporations far in excess of the Government requirements. It is simply a case of the market running away with the supply, and will only be temporary in our judgment.

We notice that the proposals from the Reclamation Service have been modified so as to leave out nearly all the objectionable features in the old proposals, and we do not think there is any reason why any cement maker would not take on this business now under present conditions, provided he had the cement to sell.

From what we understand of the operation of the plant at Phoenix, or, rather, Roosevelt, we hardly think the experiment will encourage the Government to go further in making cement.

We received copies of several Government advertisements to which no reply was made. Might have been able to fill the 2,000-barrel contract, but not justified in quoting on any larger; no indication of what Government was willing to pay for cement; daily capacity of mill about 1,300 barrels. On account of high freight rates from our mill, as compared with other producers more favorably located to deliveries required by Government, we felt it useless to quote on the contracts.

We have been asked on several occasions to bid on cement requirements for the Government, however, declined to do so, for the reason that in every instance the freight rate was against us.

We have received frequent requests from the Government for bids on cement for Reclamation Service, but as the conditions under which they require the cement to be delivered are burdensome and not to our advantage we have refused so far to make any quotations. If the Reclamation Service will arrange to receive and accept the cement at the mills of the company, they would, I think, get a good many more bids in answer to their requests, but no manufacturer will submit to shipping cement several thousand miles away, subject to condemnation at destination. We can sell all the cement we are making nearer home, and know there will be no question about its acceptance, and if there is we can easily dispose of it in adjacent territory. This would not apply to shipment to the Government at far-off Western points.

We have from time to time received specifications requesting bids for delivery in Arizona, but did not make quotation owing to the location of our plant, and high rates of freight it would have been necessary to pay. We felt that this business could be handled to better advantage by plants located west of the Mississippi River, who would have the advantage of considerably lower rates of freight than would be the case from our plants.

The point of greatest interest in the above letters, we believe, is the remarkable extent to which the cement makers of the West are enlarging their plants to provide for the requirements of the immediate future. That the Reclamation Service is having difficulty just now in securing cement appears to be true; but so are other buyers all through the West, and for that matter, in the East as well. The engineer or contractor or builder who was able to foresee his requirements for cement for this season's work and to contract therefor several months in advance has had good reason to congratulate himself for his good management in that particular. But while it is true that the consumption of cement is increasing at an astonishing rate, the expansion of capacity which the above letters indicate promises to be sufficient to meet the demand. It may even be that we shall witness another period of overproduction and resulting low price, such as prevailed two years ago. That condition was probably partially responsible for the growing up of a hand-to-mouth custom among cement users. As long as cement could be bought by telegraph and the order promptly filled from stock, contractors and engineers would not take pains to anticipate their needs.

We do not, however, look for a return of such conditions, nor are they in the long run for the best interest of either producer or consumer. The check to cement mill building, consequent upon the low prices of 1904 is chiefly responsible for the scarcity of cement this season.

Procrastination in the purchase of material is one of the most common causes of delay on engineering works. While the expense of storage and rehandling usually causes cement users to delay deliveries until the cement is actually required, there are large advantages in having the cement on the ground at least two months in advance of its use. A leeway is thus given for delays in shipment and transportation, and the engineer can be sure that the cement is well seasoned before it goes into the work.

As for the expressed fear that the Government will embark further in cement manufacture on its own account, we have no belief that the experiment at Tonto will be repeated. The conditions there were peculiar and the prospect seemed good that a saving could be made by manufacturing cement at the Roosevelt dam site instead of incurring the very long rail haul and wagon haul on cement brought in from outside. While reports are conflicting to some extent, the best information available indicates that the cement made there will cost the Government all told as much as if it had been bought in the open market and transported to the dam site.

If cement were made now as it was 20 years ago, in small dome kilns, it is quite probable that plants for local production, in connection with great engineering works such as the Roosevelt dam, might occasionally be practicable; but with the standard minimum unit of economical production in rotary kiln plants set at 1,000 barrels a day, one must build a plant too small for economical working, for a single engineering work capable of absorbing so much cement for any considerable time seldom occurs.

About the only exception to this statement is the Panama Canal locks. The six locks at Panama may require as much as 2,500,000 cu. yds. of concrete, or say 4,000,000 barrels of cement. If the work is distributed over four years this would mean a consumption of 1,000,000 barrels a year, or the output of a 3,000 barrel per day cement plant. Even if satisfactory raw materials should be found on the Isthmus, it is not at all likely that this cement could be made as cheaply as it could be in the Lehigh district of Pennsylvania, or perhaps on the Hudson River; and a Panama plant would have to be justified, if built, on the saving in packages by handling the cement in bulk from the mill to the work. It is quite possible, however, that the same thing could be done with cement from the United States. No reason is apparent why cement might not be shipped in tight box cars and tank steamers from the United States to Panama and delivered in bulk on the work. The thorough mixing which the cement would receive in trans-shipping would be a benefit and while a trifling percentage might be caked from moisture on arrival at destination, the lumps could readily be screened out and crushed. The saving in such shipment on a 4,000,000 barrel contract over the cost of barrels or other packages and the expense of putting the cement into the packages would amount to a very large sum.

LETTERS TO THE EDITOR.

Another Stuck Transit Taken Off.

Sir: I have just removed a transit which was stuck on its tripod by wrapping the head with a thick cloth saturated with hot water. I had first tried the methods described in the last volume of the News at pp. 365 and 389, which failed to work. I have sometimes warmed the metal with my hands, but as the mercury is now about 102° F. in the shade here, that method would not work.

Edwin Squire.

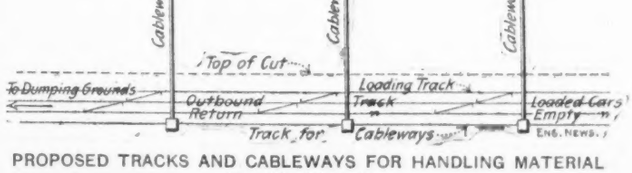
Claremont, Cal., July 5, 1906.

Another Plan for Digging the Culebra Cut.

Sir: Here is a proposed scheme for handling the excavated material from the Culebra cut on the Panama Canal, and if you think it worthy of space in your paper you can publish it.

First I would call the reader's attention to the fact that putting the tracks in the bottom of the Culebra cut for handling the excavated material would be an expensive method because the tracks in the cut could never be kept in first-class shape for rapid transportation of material as they would have to be moved or rebuilt each time a steam shovel finished its cut. Further, if all tracks and equipment for excavation were in the bottom of the cut, the space would become limited for the free handling of trains. There are other reasons why the tracks should not be put in the bottom of the cut, but time or space will not permit their specification here.

The scheme proposed by the writer would be to build a three-track railway on one or both sides of the cut for the transportation of the excavated material, and to use



PROPOSED TRACKS AND CABLEWAYS FOR HANDLING MATERIAL AT CULEBRA CUT.

cableways, supported on tracks, for handling the excavated material from the cut to the cars, and thus to do away with all unnecessary tracks, machinery, etc., in the cut.

Any required number of cableways could be installed and could handle large skips which could be loaded either by steam shovel or by hand. Skips with a capacity of 3 to 4 cu. yds. could be handled on an average of one in a minute and a half, if cars could be had for loading.

The three-track railroad would give a return track for empty cars, an out-bound track for loaded cars, and a loading track. A set of crossovers should be placed at the end of each cableway district, as shown on the accompanying plan. This three-track road could be built and put in first-class shape, and kept in order with very little expense until the cut is finished. Trains run over such a track would have fewer accidents and less delay in going to and from the dumping ground and there would be no interference between trains going to and from the dumping ground and trains being loaded.

Yours very truly, Chas. L. Marsh, C. E.,

Box 546, Tiffin, Ohio, June 21, 1906.

[We like this plan better than the tunnel plan,

described in our issue of May 17; but the introduction of the skip and cableway between the steam shovel and the car seems a roundabout method of working. We doubt whether the cost of moving the tracks supplying cars to the shovels will be as great as the cost of the cableways and their operation and maintenance would be. It must be remembered that the bottom of the Culebra cut is wide enough to run a three or four or five-track railway through the center and leave it undisturbed while the mass of material at either side is being taken out and transported. While a great amount of money will have to be spent in temporary tracks, it will be small, after all, compared with the yardage of the material to be moved. Railways are making big excavations all the time with steam shovels and cars, and no reason is apparent why the cost of track moving per cubic yard of material moved should be any more at Culebra than in the ordinary big gravel pit of a railway company.—Ed.]

Sewage Disposal in England.

Sir: There are two subjects referred to in the "Sanitary Record" (London) of May 31, 1906, deserving of consideration by all concerned in sewage disposal.

One is the discussion at a district meeting of the British Association of Sewage Works Managers, regarding the fertilizing value of sewage sludge; how it is in increasing demand at a small but advancing price by reason of the excellent agricultural results shown over all ordinary manure; how farmers using it for hay and vegetables cannot be competed with by those who do not use it.

The other matter is an important court decision in the case of Hebont vs. Southend-on-Sea for sewage pollution of oyster beds, in "The Law Journal" of March 3, 1906.

This, as is stated, dispels doubts on law points of such pollution. The defense set up that pollution was not proven, and even if it was, there was a common law right for a municipality to discharge sewage into the sea. The judge held, however, that the pollution was proven, and that there was no common law right for any party to discharge sewage into the sea to the injury of another, and he granted an injunction restraining such pollution, and assessed damages against the town at £1,500. As the case was decided according to the "common law," which prevails in this country, it is a precedent for similar action in any of our state or federal courts when such litigation comes up.

F. Noble.

26 Court St., Brooklyn, N. Y., June 27, 1906.

[See also the British Decision in the foreshore pollution case of Foster vs. Warblington, on another page of this issue.—Ed.]

The Effect of the San Francisco Earthquake on a Reinforced Concrete Floor Slab—Correction.

Sir: The writer notes an article in your issue of June 21, written by C. E. Day, of 2217 Dwight Way, Berkeley, Cal., under the heading of "The Effect of the San Francisco Earthquake on a Reinforced Concrete Floor Slab." The facts of the case are entirely misstated by the author, which we presume occurred from a lack of thorough investigation. We feel that the article gives an unfair understanding to the readers of your paper, of the building in question, therefore, with your permission, we desire to give the true facts of the case.

The American-Hawaiian Engineering & Construction Co., Limited, of which the writer is the Engineer and Manager, is the contractor for this building, and was at work on it at the time. On the morning of April 18, immediately after the earthquake, we made an examination of this building, and found that it had not been damaged by the earthquake in the slightest degree. No crack in the brick walls or concrete floors, or displacement of material of any character, could be found anywhere. The building, in fact, was in as perfect a condition as before the shock.

The day of the disaster we opened up the building for the use of refugees, and had it fully occupied by them with their furniture, etc., until the fire encroached so near, that for their safety it was necessary to remove them.

The building on the north side took fire, being entirely demolished, a portion of its walls falling on the roof of our building and wrecking about two bays. The building adjoining ours on the east side also took fire, the west wall falling out across a narrow street, running between it and our building, and against our wall, crushing a portion of it in. It was the falling of this wall that did the damage to the building that Mr. Day attributes to the collapsing of the brick wall due to the earthquake, leaving the impression that the wall was shaken down, and the concrete floors were not affected. The brick wall fell over on our building, crushing in a portion of its wall. The girder, of course, having no bearing on the wall side, fell down, leaving the concrete floors suspended by the steel rods; this floor, however, fell down a few days later, practically from its own weight.

Our building was slightly damaged by fire, to the extent of a few window openings being burned out on the street side, and had it not been for the falling of the wall of the adjoining building, ours would have escaped with practically no damage whatever; the earthquake having done no damage whatever, and only three window openings being burned out by the fire.

The writer feels that it has been the tendency of those interested in reinforced concrete construction to take advantage of the present opportunities to further the interest of reinforced concrete, condemning, universally, the use of brick construction, and that in their over-zealousness they have in many cases been unfair in their criticisms.

The writer in his examination of the effect of the earthquake has found many examples, both in concrete and brick, where it withstood the shake without any apparent effect, while again he finds cases where both concrete and brick construction were badly wrecked, both by fire and earthquake. In each case, before a fair decision can be made, the conditions surrounding it should be taken into consideration, such as bad designing and execution, severity of the shake and intensity of the fire, etc. In summing up the entire matter, it seems to the writer that bad designing and inferior execution of work are responsible for the greatest amount of the damage done in this city. It is more a question of proper and intelligent designing to suit our conditions that should command our attention at this time, and if buildings are properly designed and executed conscientiously, satisfactory results can be obtained, whether of concrete or brick.

F. J. Amweg, M. Am. Soc. C. E.

332 Turk St., San Francisco, Cal., July 2, 1906.

Concerning the Reinforcement of Concrete Columns.

Sir: Since addressing to you my letter of April 30 (published in your issue of June 14) concerning "A Method of Designing Reinforced Concrete Columns," I have been fortunate enough to come across in a German publication a reproduction of a photograph of a column which failed by shearing along a diagonal plane. The illustration shows that the column was reinforced by both longitudinal and spiral steel. From the appearance of the reinforcement it is evident that the longitudinal rods were of little value, however, in preventing the failure.

Considere reports that spiral steel is 2.4 times as effective as longitudinal reinforcement of equal weight, and this figure was closely checked by v. Bach of Stuttgart.

The experiments to which the writer referred in connection with the ineffectiveness of such longitudinal steel, have not as yet been published by the experimenters and the writer does not feel at liberty to describe them more minutely than to say that the most noticeable effect of such rods was often to hasten failure near the ends of the columns by splitting them.

Mr. Howard in a paper before the Association of Portland Cement Manufacturers makes some reference to the ineffectiveness of vertical rods in columns. It thus seems clear that such an application of steel is nearly useless from a mechanical point of view and with unit stresses for concrete and steel of even 500 and 16,000 lbs., respectively, the concrete would have to cost over $8 per cu. yd. to be commercially equivalent to steel at 2 cts. per lb. When a unit stress of 1,000 lbs. can be employed (as is entirely safe in many places) and where the price for steel is high, the economic superiority of pure concrete is evident.

What is needed most of all at the present time, as the writer said before the Association of Portland Cement Manufacturers at their last meeting, is a cement of much higher strength and of much greater uniformity.

In designing and testing columns containing longitudinal rods, great care should be used in selecting or ascertaining by experiment the modulus of elasticity for the steel between various small limits at varying loads. The quantity so determined is not at all the same one which is found by analyzing beam experiments with simplified formulas. The latter is a quantity containing many neglected factors which must be ignored if a simple formula is desired.

In conducting a column test, the specimen should be carefully prepared so as to bring all reinforcing rods into action, if large results for them are desired. In most columns constructed in building practice the rods can receive their stresses only through adhesion, and near the bottoms of most columns the adhesive stress must be something enormous, or else the bearing value of the concrete under the ends of the rods must be prodigious, if the stresses assigned to the rods are to be transmitted into the foundations.

The best method of determining the actual stresses in the steel and the concrete of a column to be tested is to build the specimen so that there is a sufficient amount of concrete between the ends of the rods and the ends of the columns, to allow the points of the apparatus to be used for determining compressive strains and permanent sets, to be placed opposite the ends of the rods. In applying the loads, the permanent set should be ascertained after each added increment. Then with a knowledge of the exact modulus of elasticity of the steel being used a very probable ratio of loading on steel and concrete can be computed.

Some years ago the writer spent considerable time and money visiting all laboratories where it was known that experiments had been made on reinforced concrete columns. Such information as engineers and contractors obtain by personal experimentation and investigation is of commercial value and is often guarded as a valuable asset. That is probably one reason why the inquiry of your correspondent received so few and such evasive answers.

It would perhaps be wiser to make public all known tests if the building laws of some of our cities could be improved thereby. At the present time some of them make reinforced concrete columns of such absurd dimensions as to be impossible from a commercial point of view. Entirely rational building laws are perhaps more than we can expect, but much can be done toward bettering the present laws.

At the present time the tendency seems to be toward some form of spirally reinforced column which will contain only enough longitudinal reinforcement to take up bending strains from eccentric loading.

Yours truly, E. P. Goodrich,
Consulting Engineer.
1170 Broadway.

1170 Broadway, New York, N. Y., June 14, 1906.

Notes and Queries.

E. P. L., Buffalo, N. Y., inquires as to the length of the longest tangent and longest curve on any railway in the United States. We refer the question to our readers. If memory serves us rightly, there is a tangent 65 miles long on a railway in Argentine; but we recall nothing published regarding long tangents in this country. By longest curve, we suppose is meant the greatest length without intervening tangents, whether the curve be simple or compounded.

In the obituary notices, which appeared in our last issue, on Mr. Charles Paine and Mr. George Y. Wisner, a list was given of their contributions to professional literature in the "Transactions" of the American Society of Civil Engineers. By an error they were put down as the authors of several papers where they merely contributed to the discussion. The papers which were erroneously credited to Mr. Paine were: "Designing and Erection of the Oakley Arch," "Efficiency of Railroads for the Transportation of Freight." Likewise those erroneously credited to Mr. Wisner were: "Origin of Gulf Stream and Circulation of Waters in the Gulf of Mexico," "Reservoir System of the Great Lakes," and "Economic Depth for Canals."

FIRE-BOX STEEL—FAILURES AND SPECIFICATIONS.*

By Max H. Wickhorst.†

The author has for several years given considerable attention to the subject of care of locomotive boilers, including the study of failures of fire-box sheets, and he hopes the following discussion on this subject may prove of some interest and usefulness.

In general, fire-box sheets fail in one of two ways: (1) gradual failure; the sheet may have a good many

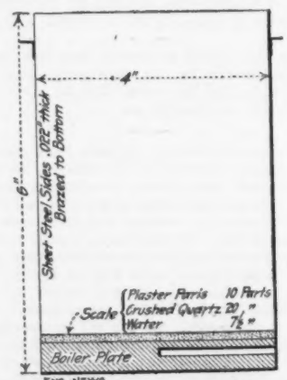


Fig. 1. Details of Apparatus Used in Making Temperature Tests of Fire-Box Steel.

small cracks which are mostly in a vertical direction. These cracks radiate thickest from the stay bolts and frequently run from one stay bolt to another in the same vertical row, but never between stay bolts horizontally. They are almost always on the fire side and

*Condensed from a paper read before the American Society for Testing Materials.

†Engineer of Tests, Chicago, Burlington & Quincy Ry.

extend through the thickness of the sheet, first going through next to the stay bolts. Such sheets are generally accompanied with more or less corrugation and the cracked and corrugated condition is almost always confined to the lower half of the sheet. (2) Sudden failure or rupture; the sheets may fail by a single crack or fracture from a foot to several feet long. In bad cases the crack may extend from the mud ring to the

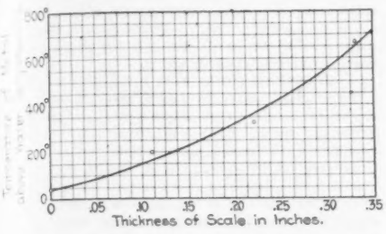


Fig. 2. Curve Showing Variation of Temperature of Fire-Box Steel, Caused by Various Thicknesses of Scale.

crown sheet, but ordinarily the crack is confined to the lower half of the sheet, extending upward from the mud ring or from a few inches above it, and is always near the middle of the side sheet longitudinally. Such sheets may show no corrugations and may show very little if any other defects.

CONDITIONS OF FAILURES CLASSIFIED.

About two years ago a lot of records and papers concerning failures of fire-box sheets were gathered out of the files in the Superintendent of Motive Power's Office of the Chicago, Burlington & Quincy Ry. for lines east of the Missouri River, and a classification made of the conditions under which the failures occurred, with results as shown below. These failures include only those occurring in class two mentioned above, or ruptures.

	Number.	Per cent.
Washing—Cooling	3	7.7
" Using nozzles	16	41.0
" Filling	2	5.1
" After filling	7	17.9
In shop or house, cold	7	17.9
In house, hot	2	5.2
Discovered arriving at terminal	2	5.2

It will be noted from the above that 71.7% occurred while the engine was being washed, this including 41% where nozzles were being used at the time; 17.9% occurred while the engine was cold under other circumstances, making a total of 89.6% for the failures while the engine was cold. This leaves 10.4% for failures while the engine was hot, but it is not improbable, if full details of the conditions attending the failures in these latter cases were at hand, that in some or perhaps all, the records would show the engine had been cold. When washing the boilers, cold water had probably been used in all cases, and the above figures would seem to argue very strongly in favor of keeping the boiler continuously hot, and the use of a method of washing where the boiler does not get cold, say not below 150° F.

TEMPERATURE TESTS OF FIRE-BOX STEEL.

If the metal is at any time heated to a red heat or to near a red heat failure from this cause would be the natural result and in order to get some information concerning the temperatures actually attained by locomotive fire-box sheets, etc., under conditions of service, an electric pyrometer, consisting of a platinum thermo-couple and galvanometer, was obtained; with the intention to work the boiler at rates similar to service conditions and insert the junction of the thermo-couple through a small hole drilled in a stay bolt, extending across to near the fire side. Tests of this kind have not as yet been made, but some preliminary results have been obtained with the apparatus shown in Fig. 1. The method of test consisted of boiling water in a can with thin sheet steel sides, with a bottom of ¼-in. boiler plate, 4 ins. in diameter brazed to the sides. The boiler plate had a hole drilled in the side ⅛-in. in diameter extending to the middle of the plate. Heat was supplied by a specially constructed "Pepper Box" burner which gave a lot of gas flames over a flat circular area of about 4 ins. in diameter. The junction of the thermo-couple was inserted into the hole of the plate to the middle, and the temperature read on a galvanometer. Some preliminary results are shown in Fig. 2, from which it will be noted that if a fire-box sheet (including flue sheet) or the flues are free from scale or mud, the temperature of the metal probably does not at any time exceed the temperature of the water more than 50° F., providing of course the circulation is sufficient to keep the water always in contact with the metal. Under the conditions of this experiment with no scale or water on the plate, the metal attained a temperature of about 1,300° F., and it will be noted from the diagram that with ⅛-in. scale the metal attained a temperature of about 200° F. above the temperature of the water; with ¼-in. something over 400° F.

In a locomotive fire-box, the average temperature of the metal, if not protected by the water, would probably run between 2,000° and 3,000° F., and with scale ⅛-in. thick and with water in the boiler, the experiments indicate that the metal including fire-box ends of the tubes, can readily attain a temperature of several hundred degrees above the temperature of the water, and it is not unlikely in some cases the metal actually attains a low red heat.

MUD ACCUMULATIONS.

The action of the heat causes the water to flow upward between the tubes, and the counter current must flow downward between the tubes and shell of the boiler. The water evaporated from the side and other sheets of the fire-box is probably supplied mostly by a current flowing backward along the bottom of the barrel of the boiler. When this current reaches the flue sheet it divides, half going to each side water leg, the current finally ending in the back water leg where the two side currents meet. Of course while this backward movement of the water is going on, the formation of steam also maintains an upward movement. This circulation carries all solid material that is light enough to move with the water, into the back water leg where the circulation is probably least rapid. The heavier particles of mud and very light scale deposit on the back mud ring up as high as the fire line which is about 6 ins. above the mud ring. There is on the back mud ring a cubic boiler, as determined by a view through an inspection hole in the back flue sheet under the flues. Where there are also scale deposits, these will be found mostly in the barrel of the boiler and on the front mud ring as scale is too heavy to be carried round by the circulation, but the mud deposits will be found about as described above. The usual scale and mud deposits are illustrated in Fig. 3. Up to a height of 4 or 6 ins. above the mud ring, the mud accumulations remain below the fire line and cannot cause overheating of the sheets, but if more mud is allowed to accumulate in a boiler, it cannot be taken care of in this space. Such excess mud makes more or less trouble by keeping in the water circulation, depositing quickly on the tubes, crown sheet and particularly in the side and back water legs as soon as active steam production stops, and in this way is apt to cause overheating of the side and back fire-box sheets by preventing free access of water.

If by means of a blow-off arrangement the back mud ring can be kept free from mud, it would seem clear from the above considerations that the boiler can be kept free from excessive mud accumulations since all the mud is carried by the circulation into the back mud ring. A blow-off in the middle of the back water leg right above the mud ring removes mud from where it tends to accumulate most, but experience has shown the author that the mud is removed right around the blow-off cock, but that on either side, the accumulations are not disturbed. This led to the trial of a blow-off pipe lying the full length of the back mud ring and perforated with holes spaced about 4 or 6 ins. apart. This arrangement has been tried somewhat extensively, and experience shows that mud can by this means be thoroughly removed from the boiler without the necessity of cooling down the boiler and washing.

Where water is treated with soda ash, the function of the soda ash is to cause the lime and magnesia salts to come down as a sludge instead of adhering as scale, and the circulation then carries the sludge into the back water leg where it can be successfully removed through a perforated blow-off pipe placed on the back mud ring. By a combination of treatment of water with soda ash, the perforated blow-off pipe mentioned and a system of blowing out at terminals, engines can be made to run regularly 5,000 miles between wash-outs, without change of water other than that obtained by the blowing out at terminals. A perforated blow-off pipe arrangement suggested for general use is shown in Fig. 4.

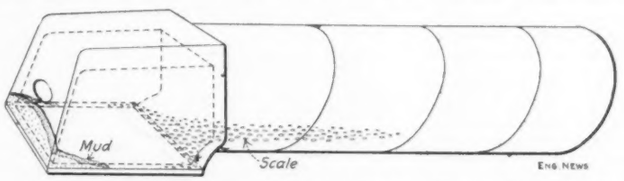


FIG. 3. SKETCH SHOWING THE USUAL LOCATION OF MUD AND SCALE DEPOSITS IN BOILERS.

TEMPERATURE TESTS OF INJECTED WATER.

The water supplied the boiler by means of an injector has a temperature ranging from 150° to 180° F., while the water in the boiler has a temperature with modern engines not much below 400° F. Where water is injected into the boiler through an ordinary check valve placed on each side, this water drops to the bottom of the boiler unless there is active steam production going on to promote circulation.

If an engine is standing still, as for instance, at a station, and the injector is on, the injected water seeks the lowest part of the boiler, which would be the water legs around the fire-box. In order to find out what was the extent of the segregation of such injected water some tests were made with thermometers inserted into the side of the boiler as shown in Fig. 5. The apparatus consisted of a brass oil cup, which extended about 4 ins. into the water, holding an ordinary chemical thermometer and a guard made of gas pipe which protected the thermometer. The oil cup and thermometer guard are shown in Fig. 6.

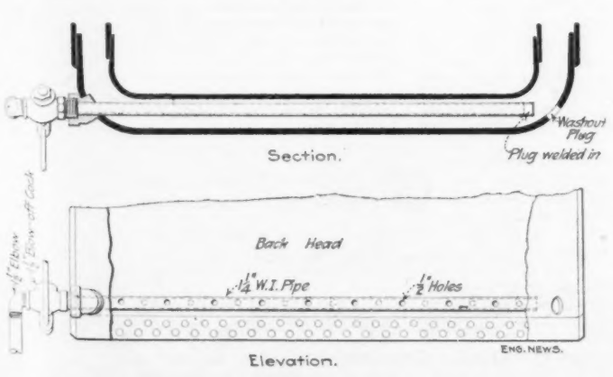


FIG. 4. DETAILS OF BLOW-OFF PIPE IN WATER LEG, SUGGESTED FOR KEEPING MUD RINGS CLEAN.

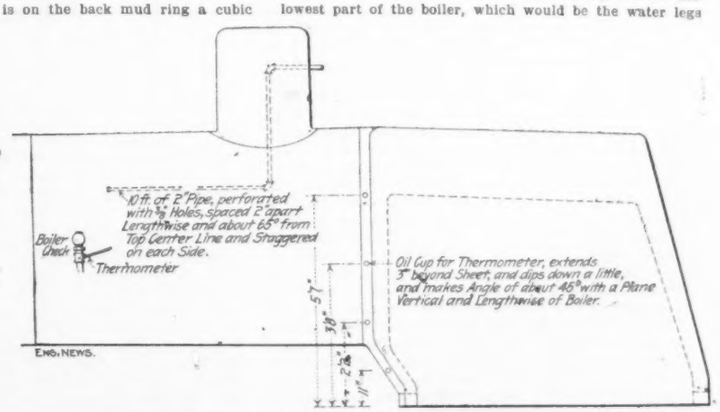

10 ft. of 2" Pipe, perforated with ⅜" Holes, spaced 2" apart Lengthwise and about 65° from Top Center Line and Staggered on each Side.
Boiler Check
Thermometer
Oil Cup for Thermometer, extends 3" beyond Sheet, and dips down a little, and makes Angle of about 45° with a Plane Vertical and Lengthwise of Boiler.
ENG. NEWS.

FIG. 5. SKETCH SHOWING LOCATION OF THERMOMETERS FOR DETERMINING THE VARIATION OF TEMPERATURE IN BOILERS DUE TO INJECTED WATER.

It will be noted that the oil cups were inserted into the left front corner of the outside fire-box sheet, one about on a level with the crown sheet, one about 7 ins. above the mud ring and two applied in between. They were placed just a little ahead of the back tube sheet. One thermometer was also arranged in the delivery pipe just below the boiler check, in order to get the temperature of the water before entering the boiler.

The method of test was to get the water level at or near to the bottom of the glass, raise steam pressure to

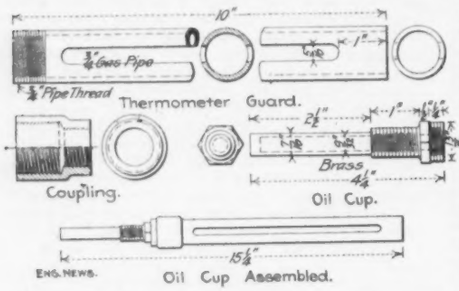


Fig. 6. Details of Oil Cups for Holding Thermometers in Boilers.

195 lbs., as shown by the gage on the engine, and take temperature readings. The tests were made in the round house, steam being produced by firing the engine with bituminous coal. They were intended to simulate the condition of an engine that had just arrived at a station, and whose injector is applied to pump water while the engine is standing still. Having obtained the water level and pressure as before mentioned, the injector was applied and the boiler filled to the top of the glass, temperature readings being taken every minute in most of the tests.

Test No. 1 was made by injecting the water through the left boiler check in the ordinary manner, all of the thermometers being also on the left side. The highest thermometer, which was on a level with the crown sheet, did not drop very much in temperature, but the lowest thermometer started to drop as soon as the injector was applied and during the filling of the boiler, dropped about 105° F. Test No. 2 was made in the same way and showed about the same results. Test No. 3 was made by delivering the water through a pipe run for convenience through the whistle hole in the dome, then down to the flues, and finally through 10 ft. of 2-in. pipe placed lengthwise over the flues. This last length of pipe was perforated with ⅜-in. holes spaced 2 ins. apart lengthwise, about 65° from the top center line and staggered on each side. This pipe is shown in Fig. 5. The highest and lowest thermometers had about the same temperature at all stages of the filling of the boiler, showing that the injected water was well mixed with the water already in the boiler. Before starting in on the test, in order to determine the amount of water required to fill this boiler, we ran the water through a 3-in. Crown water meter and found that to fill the boiler to the bottom of the water glass it took 289 cu. ft. and to the top of the glass 50 cu. ft. additional, or in round figures this would be 2,400 and 415 gals., respectively. In other words, if we have water in the boiler to the bottom of the glass and then add water to the top of the glass, we add 17% additional water. Test No. 4 was made by delivering the water into the boiler on the right side in the ordinary manner while temperature readings were taken on the left side. The lowest thermometer dropped about 45° F. below the highest during the filling of the boiler from the bottom to the top of the glass.

In comparing tests 1 and 2 with test 3 there is one very interesting point, namely, much greater drop in steam pressure during test 3. The explanation for this is undoubtedly that in tests 1 and 2 the injected water did not get mixed very much with the upper layer of water, and therefore did not condense much steam, while in test 3 the mixture was very thorough and a correspondingly greater amount of steam was condensed.

Test No. 5. In this test the water was delivered into the boiler through a perforated pipe placed transversely over the flues, the pipe being an extension on the boiler check. To carry out this arrangement the boiler check was raised 15 ins., so as to bring it above the level of the flues. A special brass flange was made that would fit the contour of the boiler at this point. The flange was fitted to the boiler and a bushing screwed into the flange, the pipe being previously screwed into the bushing, and lastly, the check was screwed into the bushing also. The pipe was of 2-in. size, 4 ft. long, and perforated with ⅛-in. holes spaced about 1¼ ins. apart lengthwise, about 65° from the top center line, and staggered on each side. The pipe was put in so that the holes faced downward. The mixing of the injected water with the water in the boiler was fairly satisfactory, although not quite as good as in test 3, where the longitudinal pipe was used.

Test No. 6. This test was made the same as test 4, except that the holes faced upward instead of downward. The results show about the same as test 5, except that the mixing was slightly better. At this point in the course of our tests it was thought desirable, if possible, to get some arrangement or extension attached to the check that would turn the water upward, and in this manner get the mixing of the injected water with the water in the boiler. For this purpose the following tests were made:

Test No. 7. A sort of scoop extension turned upward at the end but open on top was attached to the check. A trial was made of this to see how it directed the course of the water by running hydrant water through the check with this attachment out into the open air. It was found that the water was turned upward but spread out fan-shaped, and showed that this device did not accomplish the desired mixing.

Test No. 8. It seemed now that what was necessary was to direct the water upward with more velocity and in a more solid stream, so that the delivered water would get toward the top before the resistance stopped its progress and turned it downward. For this purpose a brass extension extending almost to the flues and closed at the end, but with a 1⅛-in. hole bored into it, facing upward, was screwed into the check. Tests made of this with cold water, as before mentioned, showed that the water was directed upward with some force, but the stream was not a solid one, although it was considered sufficiently satisfactory for making a test. The mixing was fairly satisfactory, but possibly could be improved by having the water directed upward in a more solid stream.

When the injector is applied with ordinary boiler feeding arrangement and no steam is being drawn, the water flows toward the bottom of the boiler and cools the lower parts, in some cases 100° F. in a very few minutes time. This, of course, results in putting considerable stress on the lower parts of the fire-box sheets and prob-

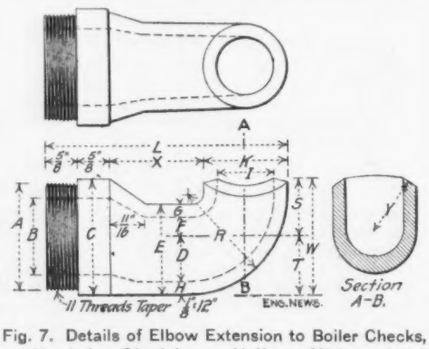


Fig. 7. Details of Elbow Extension to Boiler Checks, Used for Obtaining a Uniform Mixing of the Injected Water with the Heated Water.

Check.	A	B	C	D	E	F	G	H	I
	Inches								
1½	1⅜	1	1⅜	⅛	1⅛	7/16	⅜	⅜	1
2	2⅛	1⅛	2⅛	¼	1⅝	½	½	½	1⅛
2½	2⅜	2	2⅜	1⅛	2⅛	½	½	½	1⅛
2½	2⅜	2	2⅜	1⅛	2⅛	½	½	½	1⅛

Check.	K	L	R	S	T	W	X	Y
	Inches							
1½	1⅜	4⅜	1⅛	7/16	7/16	1⅜	2	1⅛
2	1⅝	4⅞	2	1⅛	1⅛	2⅛	1 7/16	1 5/16
2½	1⅝	4¼	2⅛	1⅛	1⅛	2⅛	1 7/16	1 5/16
2½	1⅜	4¼	2⅛	1⅛	1⅛	2⅛	1⅜	1 5/16

ably aggravates the development of cracks. After some experimenting and close watching of flue work, the Chicago, Burlington & Quincy Ry. adopted on all engines the elbow extension to the boiler check, shown in Fig. 7.

TEMPERATURE TESTS FIRING UP.

By the ordinary method of firing up a locomotive boiler where a bank of fire is made in the back part of the fire-box, the upper layers of water heat faster than the water at the mud ring and below the flues, with a result that differences of temperature may exist between mud ring and crown sheet of 200° F.

An arrangement intended to produce circulation and thus get more uniform temperature in the boiler is shown in Fig. 8. This is a nozzle arrangement through which steam or air can be injected into the water, and in this way produce a movement upward. A trial of this arrangement has shown that steam produces local elevations of temperature, and by means of air a more uniform temperature is obtained.

Although fair results as regards uniformity of temperature can be produced by injecting some air into the boiler near the mud ring, still some inconvenience is attached to its use, and the arrangement has been used only in an experimental way. Although the differences of temperature in the ordinary method of firing up are great, still they are comparatively infrequent, and do not occur suddenly, and it seems a little doubtful whether much trouble can be attributed to the temperature differences occurring while firing up.

SPECIFICATIONS FOR FIRE-BOX STEEL.

The extreme limits for tensile strength of the various American specifications require fire-box steel to have 50,000 lbs. per sq. in. as a minimum and 65,000 lbs. as a maximum. In foreign specification, the minimum limit seems frequently to run below 50,000 lbs. per sq. in. Formerly the American requirements for tensile strength were 50,000 lbs. as a minimum and 60,000 lbs. as a maximum. About 15 years ago these limits were raised and were made 55,000 to 65,000 lbs., respectively, based apparently on the initiative of the Pennsylvania Railroad Co. Within the last few years, however, there has been a tendency to lower the limits, and the present limits of the American Railway Master Mechanics' Association are 52,000 to 62,000 lbs. It will be seen from what has been presented above that under ordinary conditions of service, the locomotive boiler (including fire-box, and especially the lower parts), is frequently subjected to severe overheating, differences of temperature and severe and sudden changes of temperature around the lower parts of the fire-box and lower flues. It seems to be the result of experience that the harder grades of fire-box steel do not stand these abuses satisfactorily, but seem to develop cracks and ruptures, and very soft steel, under similar conditions, seems to stand these abuses a longer time before failure occurs, and, in fact, may become badly corrugated and distorted and still remain serviceable. It has been the author's experience that, as a general proposition, where fire-box sheets fail from single rupture without otherwise being badly cracked or corrugated, the carbon runs toward 25% or higher, and may run as high as 35%. On the other hand, the sheets which fail by corrugation and gradual cracking generally contain carbon between 12 to 25%. It seems, therefore, that as a general proposition, the softer grades of fire-box steel give better service than the harder grades, and the Chicago, Burlington & Quincy Railway Co. has recently changed the requirements for fire-box steel to tensile strength running from 50,000 to 58,000 lbs. per sq. in., the former limits being from 55,000 to 65,000 lbs. per sq. in.

It seems clear to the author, however, that the problem of long life of fire-box steel is not so much a question of quality of steel, but is mostly up to the railroads. By suitable treatment of the water supplies, a proper arrangement for delivering feed water into the boiler, and proper methods of caring for boilers in round house and elsewhere, long life can be expected with any grade of fire-box steel, and most of the complaints of poor steel are then apt to disappear.

TREATMENT OF WATER.

A matter that is very intimately tied up in the problem of the care of boilers is treatment of water. The author has studied this matter chiefly in connection with flue work, but as the good performance of flues and fire-box steel go hand in hand it may be interesting to record the results of some investigations concerning the relation of flue work and hardness, particularly, permanent hardness of the water.

In order to get some comparison of the amount of flue work and boiler washing done on switch engines at the various places on the Chicago, Burlington & Quincy Ry.

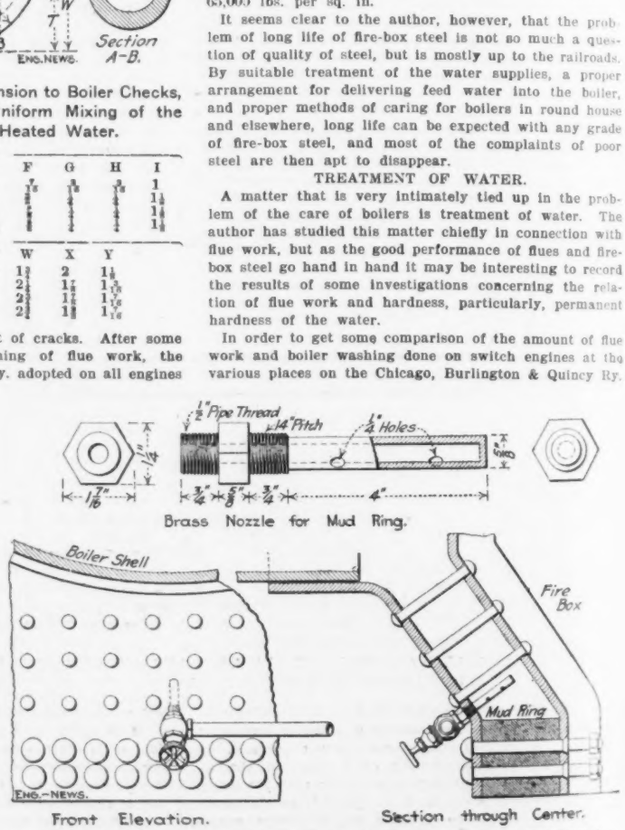


FIG. 8. DETAILS OF A NOZZLE FOR OBTAINING A MORE UNIFORM TEMPERATURE OF BOILER WATER WHEN FIRING UP.

Sys[illegible] numbers of switch engines working at some [illegible] during July, 1905, were obtained, and the [illegible] flue work and boiler washing done on these [illegible] taken from our records. This comparison [illegible] largely to note, if possible, what relation [illegible] be between the quality of the water supply [illegible] flue work and boiler washing done.

A [illegible]mary of the figures obtained follows:

Pla[illegible]	Number of engines	Miles per flue calked	Miles per washing	Source of Water. Remarks.	Hardness parts per 100,000
Chic[illegible]	36	5.8	700	Lake Michigan	13.
Aurc[illegible]	7	18.9	3,338	Fox River — Softened	14.
Gales[illegible]	10	91.2	1,112	Lake Rice—Treated with soda ash	19.
Quinc[illegible]	4	23.3	3,315	Mississippi River —Lime treatment —Jewell filter	13.
Bear[illegible]wn	3	28.2	659	Illinois River	25.
Burlington	8	62.1	2,368	Mississippi River —Softened	12.
Ottumwa	6	12.3	898	DesMoines River	25.
Grand Crossing	4	18.6	2,816	Black River, Wis.	9.
Dayton's Bluff	6	5.9	1,111	Mississippi River	10.
Savannah	2	275.0	2,291	Deep well — Softened	13.
Creston	4	76.8	1,153	Artificial lake	18.
Hannibal	5	No flues calked	1,993	Mississippi River —Settled in reservoir	23.
N. St. Louis	9	32.5	598	Mississippi River —Lime treatment —Settled	18.
St. Joseph	12	12.7	876	Missouri River—Settled in reservoirs	35.
Kansas City	10	14.3	708	Missouri River	35.
Brookfield	5	4.8	460	Yellow Creek	18.
Omaha	6	43.6	762	Missouri River	43.
Lincoln	9	7.2	792	Wells—62 ft. deep	24.
McCook	2	No flues calked	550	Wells at Republican River	28.
Denver	6	14.6	762	Wells	38.
Alliance	3	26.5	629	Three wells	27.
Sheridan	3	14.4	221	City water from Big Goose Creek	26.

From these figures it may be said, in a general way, that the miles per washing decrease as the hardness increases, which is a result that would be expected. There seems to be no relation, however, between the total hardness and the miles per flue calked, some of the lowest results being with the soft waters. Looking more closely into this feature, it will be noted that the cases where the miles per flue calked are large are the ones where the water has either been softened in a softening plant or has been treated with soda ash. In cases where the softening plant is used, part of the treatment consists of the use of soda ash, and thus it will be seen that in all cases where the miles per flue calked are high, the water really had sufficient soda ash put into it to combine with the permanent hardness or calcium sulphate.

McCook water, as far as the author is aware, is not treated with soda ash, but this is one that naturally has no permanent hardness and at times naturally has a little alkali carbonate or soda ash. The Creston record is among the high ones, but this water generally has only a small amount of permanent hardness. Hannibal gives a very high record, although the Mississippi River water at this point has several parts of permanent hardness, and this therefore seems to be the only prominent exception to the rule which we can now formulate; namely, that the amount of flue work, as far as quality of water is concerned, is a function of the permanent hardness, and within the limits of such waters as we have to use (say 40 parts per 100,000 of total hardness) the amount of flue work seems to be independent of the total hardness. Analyses of water taken from boilers have shown that the permanent hardness keeps concentrating in the boiler up to perhaps 10 or 20 or more parts per 100,000, while if there is an excess of soda ash, the water in the boiler will have very little hardness, amounting to perhaps 5 parts per 100,000.

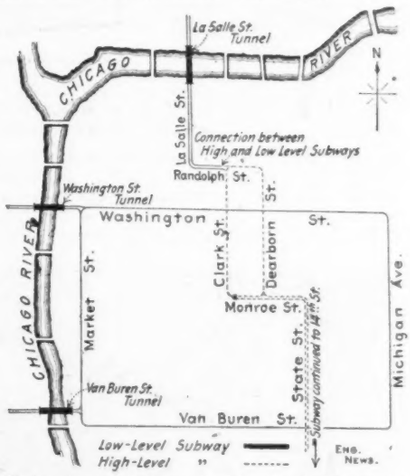
The author thinks that he may express this as the general rule that where water is free from excessive mud or alkaline salts, the amount of boiler washing under present usual arrangements on the Chicago, Burlington & Quincy Ry. is a function of total hardness, while the amount of flue work is a function mostly of the permanent hardness or calcium sulphate.

CONCLUSION.

In conclusion, it is suggested that long life of fire-box steel is to be obtained, (1) by suitable treatment of feed water; generally plain soda ash treatment sufficient to destroy all sulphate of calcium will answer the purpose, but where the water is very hard softening with lime will also be desirable; (2) by avoiding considerable and sudden variations of temperature due to cold feed water dropping to the bottom of the boiler when active steam production is not going on. Some feed water arrangement should be used which will not allow the water to thus segregate; (3) by keeping the boiler continuously hot and avoiding wash-outs, especially with cold water; a blow-off pipe on the back mud ring connected to a blow-off cock in the back corner in conjunction with a system of blowing will keep the boiler free from all accumulations if the water has been suitably treated. The blowing out is also necessary to keep the concentration of the water below the foaming point, say 200 parts per 100,000. If this is done, probably, the quality of fire-box steel is of secondary importance, but the author suggests that the quality of steel called for in the specifications of the American Railway Master Mechanics' Association, tensile strength of 52,000 to 62,000 lbs., will probably in general be most satisfactory.

A REPORT ON CHICAGO STREET RAILWAYS AND SUBWAYS.

The relations between the street railway companies and the public authorities of the city of Chicago have for a number of years been marked by complications and bitter contentions, with the result that the street railway system has been brought to a very unsatisfactory condition both as to construction and operation. This state of affairs has been cleared considerably by court decisions upon disputed points over which there has been long litigation, and it now appears that the continued discussions between



Sketch Map of Subway System for Street Cars at Chicago, as Proposed by Mr. Bion J. Arnold, Consulting Electrical Engineer.

representatives of the companies and the city, aided by the reports of experts appointed to investigate certain technical matters, may before long result in some more amicable relations with important improvements in the street railway system in general. In 1902, Mr. B. J. Arnold was engaged as consulting engineer on behalf of the city to consider the general improvement of the street railway system with a view to the more efficient handling of traffic, and an abstract of his report was published in our issue of Jan. 1, 1903. On May 31, the Council Committee on Local Transportation requested Mr. Arnold to make a supplementary report on the traction situation, bearing in mind particularly the changes that have taken place in the legal situation between the companies and the municipality since the preparation of his original report. An abstract of this second report is given below:

UNDERGROUND CONDUIT VERSUS OVERHEAD CONSTRUCTION.—In my report of 1902 (Engineering News, Jan. 1, 1903) I stated that it was feasible to construct and operate the underground conduit system for the surface lines. To use this system for the entire surface railways of Chicago would make the cost so great as to practically prohibit the reconstruction of the present systems. Therefore, if any underground conduit system is adopted at the present time it would be necessary to change from the overhead trolley to undergrouhd construction at certain points. These transfer points should be removed as far from the center of the city as possible, so as to be clear of the zone of congested traffic, but bearing in mind the largely increased cost of underground construction as compared with overhead.

It is largely a question as to how much underground conduit the city is prepared to insist upon at the present time. If this is to be only a limited amount and in the strictly central district, the benefits will not be sufficient to justify the additional cost. There are other objections to the immediate construction of the underground system in the business district, arising from the necessity of a certain amount of sewer reconstruction in that district, and the possible installation of a high-pressure water system.

The subway question is also involved, and the construction of a certain amount of subway for taking care of the cars which now pass through the river tunnels is one of the strong probabilities if not reasonable certainties of the near future. To construct underground conduit on streets which are likely to be used for subways within any reasonable time would be obviously uneconomic, as these conduits would have to be taken out in the event of a high-level subway being constructed in the same street.

Owing to the fact that the plan of financing the street railway reconstruction has radically changed since my original report, and that it is now proposed to reserve to the city, or its licensee, the right to purchase the entire railway system for the value of the present property and the additional investment for improvements, it would be wise to omit the construction of any underground conduit at the present time, but to specifically reserve (in any ordinances or permits that may be granted) the right that the city may require the construction of underground conduit as soon as the subway and sewer questions have been disposed of and the city has then determined upon a sufficient amount of conduit construction to carry the transfer points well out of the business center.

When it has become sufficiently clear that the city should and can provide for the construction of underground conduit in any one street, such as State St., for a sufficient distance to enable the cars to be operated solely by underground conduit throughout their entire course, or at least until they have reached the point where the traffic has clearly ceased to be congested, I should recommend the adoption of the underground conduit, and not until then. All feeder and transmission wires, however, should be placed underground within the business district.

SUBWAYS.—All cars which pass through the tunnels under the Chicago River should be kept underground and off the surface of the streets in the downtown business district. It seems clear that in any future development of the transportation system we shall have to use some tunnels under the river, as it will be impracticable to permanently take care of the traffic by the use of bridges alone, owing to the interference from navigation.

It is now contemplated to lower the existing tunnels as soon as a permanent solution of the traction question can be reached. That being so, we should provide for taking care of the traffic through these tunnels by the necessary amount of subway in the central part of the city, and so plan this subway that it shall be available as part of the complete system in the future. One of the plans presented with my report of 1902 contemplated the construction of some low-level subways which would conflict with the large tunnels which the Illinois Tunnel Co. was endeavoring to secure the right to build. Since then, the tunnel company has abandoned the plan of constructing these large tunnels, and is bound by the terms of its ordinance to keep its tunnels a certain distance below city datum. This places them a sufficient depth below the surface of the streets to allow the construction of the low-level street car subways, and I again recommend this plan, in general, as the best solution of the subway question, for the reasons given in my report of 1902.

Briefly, these reasons are as follows (1) Grade crossings in subway construction are avoided. (2) This subway system ultimately provides for a comprehensive downtown distributing system, and permits the universal use of transfers without injustice to any one. (3) The construction of portions of this subway system would permit the immediate adoption of through routes in subways between the north and south sides, and loops in subways for the north and west and south side systems.

I appreciate fully the necessity of confining any subway construction in the immediate future to the smallest possible amount that will take care of the traffic which is intended to pass through the river tunnels when lowered and reconstructed. This traffic can be accommodated and kept off the surface of the streets in the downtown district, and the advantages of the transfer system secured up to the capacity of the subway herein recommended for immediate construction, by a low-level single-track subway loop passing through the Van Buren St. tunnel and under Van Buren, Michigan, Washington and Market Sts., as shown on the accompanying sketch map. The complete loop thus constructed would take care of the west side traffic passing through the river tunnel until such time as it became necessary to construct a third river tunnel in Adams St. and additional loops.

By retaining the present eastern incline outlet to the Van Buren St. tunnel, which could easily be done since it is on private property and does not interfere with the surface of any street, the subway loop cars could be brought to the surface and distributed over surface loops at any time when, through accident or otherwise, congestion occurred on the west side subway loop.

To take care of the north side traffic which would pass through the reconstructed La Salle St. tunnel, there should be a low-level double-track subway extending from the tunnel south on La Salle St., gradually rising

to Randolph St., where it becomes a high-level subway; thence east to Clark St., where the tracks would divide, forming a loop on Clark, Randolph, Dearborn and Monroe Sts. Thence east on Monroe St. to State St. and south to 14th St., where would be the present southern entrance to this subway. This arrangement will permit of a double-track subway route between the north and south sides of the city, as well as providing for subway loops for all traffic coming through the river tunnels from the north and west sides. Most of the above-mentioned objects can be accomplished, though not so satisfactorily, and with some less expense, by continuing the double-track subway north on State St., from Monroe St. to Randolph St., and west to Clark St.

To construct the low-level subway loop and north and south subways, as above recommended will cost approximately $4,800,000. The double-track connection on Randolph and Market Sts., for the purpose of through-routing north and west side cars will cost an additional $40,000. If no subways are built on Clark, Monroe and Dearborn Sts., and the double-track subway is extended on State, Randolph and Market Sts. the cost would be approximately $4,500,000. The above figures do not include the cost of changing the river tunnels, or damages to property.

SUMMARY.—My recommendations as to what to do at present are as follows:

(1) Trolleyize the cable systems and the terminals in the business district to such an extent that through-routes can be put into effect, with the understanding that when the completed subway system is built the tracks in the business district will be modified to conform to the arrangement already suggested. All feeder and transmission wires to be placed underground within the business district and such other territory as the committee may determine.

(2) Take immediate steps for rehabilitating the present surface systems, and for constructing the subways herein outlined.

(3) Reconstruct the river tunnels (when they are reconstructed) at such level and in such a manner that they can be used as part of a permanent and comprehensive subway system.

SPECIAL CONSTRUCTION DETAILS IN A REINFORCED CONCRETE HARDWARE STORE.

The accompanying sketches show the form construction and concrete mixing and handling plant employed in constructing the large wholesale hardware store of Farwell, Ozman, Kirk & Co., of St. Paul, Minn. This building is irregular in plan, as shown by Fig. 1, but covers about an acre, and is 120 ft. high with nine floors. It was originally designed for slow burning mill construction, but when the owners learned that it could be built of reinforced concrete at an additional cost of only 12½% the fireproof material was adopted. The purpose of the building necessitated rather heavy construction, the floors and columns being designed for loads of 500 lbs. per sq. ft. for the first three floors, 300 lbs. per sq. ft. for the succeeding four floors, 250 lbs. per sq. ft. for the eighth, and 200 lbs. per sq. ft. for the ninth floor. It was also especially guarded against fire hazard by two vertical brick fire walls from roof to foundations, by metal frame and wireglass windows, and by having all interior wall openings closed by two fire doors hung on inclined tracks and held open by fusible links.

The reinforced concrete work comprises the floors, roof and interior columns, the walls being of brick. There are 143 reinforced concrete columns.

The rapidity of construction and the means adopted for accomplishing it are the particular features of the job. Work was begun on the column footings on April 1, 1905. On June 1 work was started on the columns and floors, and from that date until the roof was completed, Nov. 27, 1905, construction proceeded at the rate of 1½ acres of floor, including columns and girders per month.

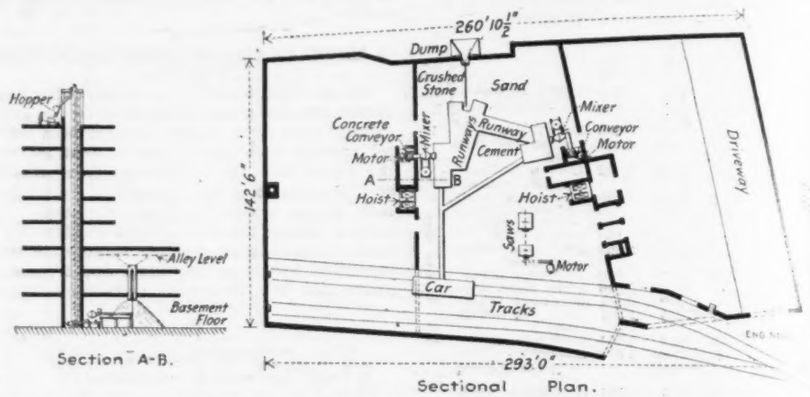


FIG. 1. SKETCH PLANS OF CONTRACTOR'S PLANT FOR REINFORCED CONCRETE WORK ON FARWELL, OZMUN, KIRK & CO.'S STORE, ST. PAUL, MINN.

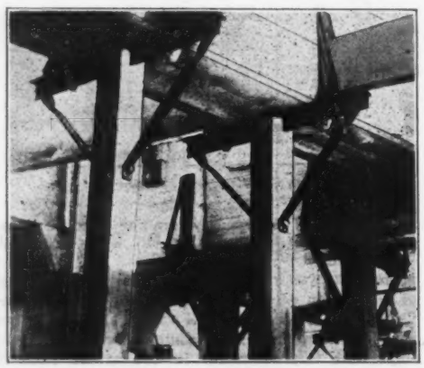


Fig. 4. View Showing Slab and Girder Floor Forms in Position.

The lay-out of the construction plant is shown by Fig. 1. In the alley near the center of the north side of the building the surface grade is about 6 ft. above the third floor level. This fact was taken advantage of in handling the stone and sand. A hopper was constructed at grade and provided with two chutes running to the basement. These chutes discharged on opposite sides of a vertical partition, and at their tops a deflector plate was provided by which either could be closed. Thus either stone or sand could be dumped into the same hopper and chute to the basement, the stone on one side and the sand on the other side of the partition. Cement was brought to the work in cars over the switch tracks shown, and was wheeled from the car over runways leading to the storage platforms near each mixer. This storage platform was extended to serve as a runway for bringing sand and stone to the [illegible] and was at such a level that barrows [illegible] emptied directly into the feeding hoppers [illegible] mixers.

Two bucket hoists were used for hois[illegible] the concrete as high as the eighth floor. Th[illegible] was raised two stories each move and carried the concrete into a hopper which was large enough to hold a batch and a half of concrete. The wheelbarrows were filled from an opening in the bottom of the hopper, which was opened and closed by a slide and operated with a lever. After the eighth floor was completed, the hoppers were placed on the fifth floor, into which the concrete was dumped from the buckets. Wheelbarrows were filled from these hoppers and carried on elevators to the remaining floors, stairs and roof.

One hoist was located in a stair well at the west division wall and supplied with power from a 20-HP. motor. The other hoist was located in an elevator shaft at the east division wall and run with a 12-HP. motor. A Smith concrete mixer was set at each hoist to dump into a chute which carried the concrete into the boot of the hoist. The crushed stone and sand was measured in wheelbarrows and dumped directly into the mixers from platforms; the cement was emptied into the mixer from the sack. Special 4-cu. ft. wheelbarrows were made for handling the concrete, and such a system was organized that a maximum of 155 cu. yds. of concrete was placed in a ten-hour day with a force of 28 men.

A small sawmill was set up on the first floor and run with a motor to cut the lumber ready to be put into place for the forms. This reduced the hand sawing to a minimum. Columns and beam boxes were all framed ready to set into place as soon as the floor below was completed. Posts, 4 × 4 ins., were used for supports, in conjunction with the beam clamps, so no diagonal braces were required. The special construction of column and floor forms is shown by Figs. 2, 3 and 4.

The drawing of Fig. 2 shows the column form, and is self-explanatory. The floor forms call for more attention. The essential feature of these is the T-standard and clamps, which do away entirely with nails in erecting the forms, and consequently with all sledging and prizing in removing them.

The building was designed by the Trussed Concrete Steel Co., of Detroit, Mich., using Kahn trussed bar reinforcement, and we are indebted to Mr. W. H. Dillon, of this company, and the designer of the floor form illustrated for the facts from which this description has been prepared.

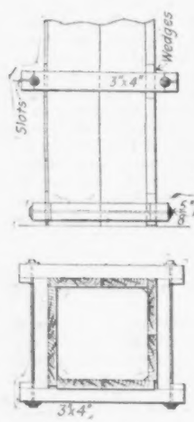


Fig. 2. Column Form.

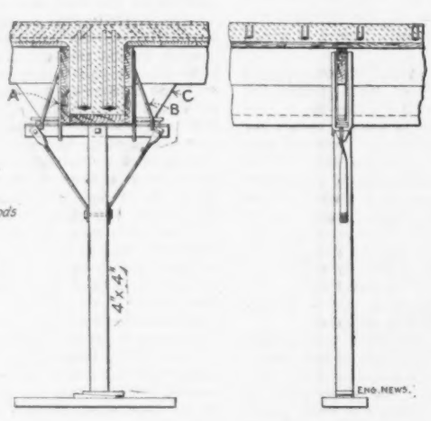


Fig. 3.

FIG. 3. SLAB AND GIRDER FLOOR FORM.

THE ENGINEERING AND TECHNICAL SOCIETIES OF THE UNITED STATES AND CANADA. (ADDENDA.)

In an article under the above title which appeared in our issue of June 21, 1906, we gave a list of the important engineering societies of the United States with name and address of the president and secretary, together with a statement of the number of members in so far

as we had been able to obtain it. This list was incomplete due to inability on our part to get desired information, and we stated in that article and again repeat that we would be pleased to receive any corrections to the list, so that our records may be complete. Following are the corrections that we have received to date:

Milwaukee Engineers' Society. Secy., W. G. Starkweather; Milwaukee, Wis.; Pres., George P. Dravo, Power Improvement Co., Railway Exchange, Milwaukee. 75 Members (about).

National Association of German-American Technologists. Secy., Aug. J. Loeser, 1122 Harford Ave., Baltimore, Md.; Pres., John Maiberg, 1708 North Bond St., Baltimore.

(Consists of the following societies:)

Technical Society of New York, N. Y. Secy., B. A. von Berge, 53 Lafayette St., Newark, N. J.; Pres., F. Lurke, Aix, 11 Broadway, New York. 115 Members.

Technological Society of Baltimore, Md. Secy., Aug. J. Loeser, 1902 Seventh St., Baltimore.; Pres., John Maiberg, 1708 North Bond St., Baltimore. 60 Members.

Technological Society of Brooklyn, N. Y. Secy., Barth. Viola, 11 Bartlett St., Brooklyn; Pres., F. W. von Egloffstein, 257 Broadway, New York. 40 Members.

Technological Society of Chicago, Ill. Secy., Alex. L. Hellbrunn, 1765 Oakdale Ave., Chicago; Pres., L. Guenzel, 1616 Ashland Block, Chicago. 30 Members.

Technological Society of Newark, N. J. Secy., Kurt Ledig, 120 Spruce St., Newark; Pres., E. W. Zeh, 213 Chestnut St., Newark. 25 Members.

Technological Society of Philadelphia, Pa. Secy., L. Eichhorn, 1428 East Columbia Ave., Philadelphia; Pres., W. M. Stein, 3409 Race St., Philadelphia. 142 Members.

Technological Society of Pittsburg, Pa. Secy., A. Kuehn, 14 Plymouth St., Pittsburg; Pres., C. Merrader, 329 Carnegie Building, Pittsburg. 158 Members.

Technological Society of Washington, D. C. Secy., Paul Bausch, 3418 Brown St., Mt. Pleasant, Washington; Pres., Jul. Ulke, 1427 V St., N. W., Washington. 30 Members.

The National Paving Brick Manufacturers' Association. Secy., (Corr.), W. P. Blair, Terre Haute, Ind.; Pres., W. P. Blair.

Structural Association of San Francisco. Secy., Prof. Charles Derleth, Jr., University of California, Berkeley, Cal.; Pres., Prof. C. B. Wing, Stanford University, Cal. 136 Members.

Technology Club of Syracuse. Secy., W. M. Booth, Dillaye Building, Syracuse, N. Y.; Pres., Henry C. Allen, 201 Delaware St., Syracuse. 135 Members.

FORESHORE POLLUTION: NOTES ON THE CASE OF FOSTER v. WARBLINGTON URBAN DISTRICT COUNCIL.

By Prof. Henry Robinson,* M. Inst. C. E.

An important case, bearing on the question of foreshore pollution, recently decided in the Law Courts, deserves notice, the plaintiff being the owner of oyster beds at Emsworth, a village at the head of a tidal creek known as Chichester Harbor, and the defendant the authority whose outfall sewer discharged sewage on the foreshore of the creek near the oyster beds. It was alleged that the oysters became contaminated by the sewage, and in November, 1902, several fatal cases of typhoid fever resulted from oysters from these beds being supplied for a public banquet at Winchester. The publicity occasioned thereby led to these beds being condemned, and the plaintiff's business ruined. The case was tried in 1904 before Mr. Justice Walton, and occupied several days.

The plaintiff purchased his oyster beds in 1870, and in 1874 the defendant council carried out some drainage works with an outfall sewer, discharging the sewage near to the oyster beds; but a penstock enabled the discharge to be controlled so as to take place at low water on the ebb tide, whereby the sewage would be carried away seaward. In 1895 the Council extended its drainage system, thus increasing the amount of sewage brought to the outfall, and the whole passed away when the tide served, as the use of the penstock had been discontinued. In 1896 Dr. Bulstrode, of the Local Government Board, visited Emsworth, as he was then engaged (owing to the "scare" at the time) in examining places where oysters were cultivated, and he pointed out the danger of the Emsworth beds being contaminated.

When the case was tried the question of "title" was first raised, and evidence was called to establish this. Then followed a number of witnesses who dealt with the history of the district, and the condition of the foreshore in past years. The fact that the plaintiff had been a member of the Council during the time that the extensions and alterations to the drainage system and the outfall were carried out, made him a party to what he now complained of, and emphasis was laid on this.

The following interesting technical and scientific evidence was then given. Professor Kenwood stated that he had visited the district and seen the sewage flowing from the outfall sewer over the foreshore and obviously passing over the oyster beds. He agreed with Dr. Bulstrode that the conditions for storing oysters at this place were disgusting. Professor Robinson followed and explained various float observations that he had made at different states of the tide which proved that the sewage from the outfall must inevitably be carried over the oyster beds at flood tides, and thus cause their pollution. He pointed out that the increased volume of sewage which passed into the outfall sewer since it was made would prevent the penstock being of any use, as the sewer became gorged.

At this stage, counsel for the defendant stated that it would now be no longer contended that the sewage from the outfall did not pass over the beds. Dr. Bulstrode then explained the results of his visit to the oyster beds in 1894, when he condemned them, and what happened at the Winchester banquet in 1902 proved that his view was correct, and he stated this in a report he made in May, 1903, after this banquet. Dr. Klein explained the results of analysis he had made on oysters and water from Emsworth in December, 1902. Every sample gave evidence of the conspicuous presence of organisms generally found in sewage. Some contained organisms which were generally associated with gastro-enteritis.

Dr. Fraser described how 30 cases of typhoid which he had investigated at Portsmouth had been occasioned by the consumption of Emsworth oysters, and he, as medical officer of health, issued a warning against eating them.

For the defence, it was contended that the Warblington Council succeeded to a bad system of drainage which existed before it came into power, and if, by reason of the inhabitants exercising their rights to connect with the sewerage system, an increased volume was created, this would give the plaintiff no right of action against the Council, as the plaintiff's beds were exposed to the operation of a sewer which existed before the Council was formed. If he had ground of complaint, he should have moved the Local Government Board, as prescribed by the Public Health Act, 1875, Section 299. It was also argued that any one had a right to drain into the sea, and further, that as the plaintiff had not taken steps for years to guard against the danger, he was guilty of "laches," and could not recover.

During the arguments for the defence, the judge observed that, although a prescriptive right to drain on the foreshore existed, and although the inhabitants had a right to connect their drains with the public sewers, there was no right to commit a public nuisance.

On the 13th of January, 1905, Mr. Justice Walton delivered judgment in favor of the plaintiff. He held that the oyster beds were well defined, and were situated on the soil of the foreshore which belonged to the lord of the manor. The beds had been in the occupation of the plaintiff for a sufficient length of time for him to have acquired a prescriptive title when the acts complained of occurred. It had been contended that the Council had a prescriptive right to discharge the sewage on the foreshore, but he considered that the original use of the outfall sewer did not involve the damage complained of, which arose from the modern practice of connecting drains with sewers. This had largely increased the amount of sewage discharged, and the abandonment of the penstock caused the sewage to pollute the foreshore, instead of being carried out to sea.

He had come to the conclusion that the lord of the manor had not only the ownership of the soil of the fishery, but also the right of "several fishery" as a right belonging to him as owner of the soil. From this, it followed that, by acquiring rights in the soil of the foreshore, the plaintiff had acquired the right of "several fishery," and the oyster beds were private beds, the rights to which had been disturbed by the defendant depositing sewage matter in them, which they had no prescriptive right to do, neither could such right be acquired, as it was a public nuisance to a public fishery. The Sea Fisheries Act, 1868 (especially Sections 51 and 53) made it criminal to contaminate oysters in private beds. This judgment was appealed against, and the case was heard before Lords Justices Vaughan Williams, Stirling and Fletcher Moulton, the hearing lasting several days. The court unanimously dismissed the appeal, and upheld the decision of Mr. Justice Walton.

The plaintiff claimed £18,000 damages, but it had been agreed at the outset to defer dealing with the amount of damages until the legal matters had been disposed of, and the defendant had been found to be liable. The claim for damages was afterwards dealt with by Mr. Justice Walton (who tried the case in 1904), and in May, 1906, he gave his judgment to the effect that the plaintiff (Foster) had been deprived of the use of the oyster beds at Emsworth from December, 1902, to the present time. He had also suffered some damage in consequence of the removal of his oysters from Emsworth to Hayling, as well as from mortality among the oysters. There was also some disturbance to his business in consequence of its removal from Emsworth to Hayling. It was very difficult to form an estimate, but the plaintiff was entitled to some damage under all the above heads.

But the plaintiff made a much more serious claim. He said that, in 1902, the public became alarmed in connection with the contamination of the Emsworth beds, and that he suffered a loss of business, for which he claimed some £10,000. Justice Walton did not think the plaintiff could recover for general depression of the oyster trade. It was not strictly caused by any act of the defendant. In 1902, the plaintiff was selling the oysters with the knowledge that they might be contaminated with sewage. The plaintiff must bear the loss caused by the general depression of the market, in the same way as other people had to do. But for the particular loss arising to the plaintiff under the heads already mentioned, he awarded him the sum of £850, the plaintiff to have the costs of the former hearing, but each party to pay his own cost of the present hearing.

*Parliament Mansions, Victoria St., Westminster, London.

THREE-CYLINDER COMPOUND LOCOMOTIVES were discussed editorially in our issue of March 8, and particulars were then given of the once-noted engines of this type designed and built by Mr. F. W. Webb, for many years the Mechanical Engineer of the London & Northwestern Ry., of England. In an obituary notice of Mr. Webb (who died on June 4) "The Engineer," of London, has the following remarks in regard to these engines:

It is as the persistent advocate of the compound locomotive that Mr. Webb will be best remembered. For more than 20 years he built nothing but compound locomotives for his fast passenger service. The first of them, the "Experiment," was put to work in 1882. These locomotives were quite original in principle, and have never been used, save experimentally, off the London & Northwestern system. Two outside cylinders fitted with Joy's valve gear drove the trailing pairs of four driving wheels. The leading pair had a single-crank axle which was worked by one very large low-pressure cylinder between the frames. The exhaust pipes from the high-pressure cylinder curled round inside the smoke-box, constituting a small intermediate receiver. The wheels were not coupled, nor was there any separate starting valve. The two pairs of driving wheels acted on the "go-as-you-please system." The train was started by the outside cylinders, which delivered into the valve chest of the inside cylinders, and the various pressures adjusted themselves, so that the distribution of work was fairly equal. The great defects of these engines were, first, that they could not run fast down hill because of the great back-pressure resistance on the huge inside cylinder, which was in the larger engines 30 ins. diameter; and, second, they were bad starters. The two small outside cylinders could not start a heavy train, but they could slip the single pair of driving wheels, and so put steam into the low-pressure chest. An engine might be seen at a station with the trailing drivers revolving on the rails until the back pressure in the receiver became too great, and they stopped; then the low-pressure engine would start. In all cases the train began to move with a more or less violent surging action, set up by the low-pressure piston, and of this the passengers complained. On the whole, these engines were not a success. It has always been impossible to obtain any accurate data as to their

consumption of fuel in regular work. In these compound engines as first built the inside cylinder was fitted with a Stephenson link motion, but in the latter engines this was suppressed, and a single eccentric took its place; this was loose on the crank shaft, and driven by springs precisely in the same way as the valves were worked in old-fashioned paddle engines. We have spoken of them in the past tense because the type is dead. Even Mr. Webb gave up building them in 1897, when he brought out a very fine four-cylinder compound engine, which has done excellent work, and is doing yet better since Mr. Whale (his successor) fitted it with separate screw-reversing gears for the high and low-pressure cylinders. In 1901 Mr. Webb put on the line an enlarged type of four-cylinder compound, representing the last work of any importance which he accomplished. The four cylinders—high-pressure outside—all work on the leading pair of four-coupled wheels, 7 ft. 1 in. diameter, and the cranks have balance weights forged on them, as in marine engines.

CONTRACTS FOR TWO BATTLESHIPS, the "Michigan" and the "South Carolina," were awarded during the past week by the Secretary of the Navy. The New York Shipbuilding Co., of Camden, N. J., and the Wm. Cramp & Sons' Ship & Engine Building Co., of Philadelphia, Pa., are to build the two vessels (which are identical). Reciprocating engines are specified. The contract prices and terms of the two companies are $3,585,000 and 41 mos., and $3,540,000 and 40 mos., respectively. Bids for equivalent vessels equipped with steam turbines ranged from $3,689,000 to $4,450,000.

THE CAPE TO CAIRO RAILWAY has now reached Broken Hill, according to the British South Africa Co. Broken Hill lies 374 miles north of Victoria Falls and is 2,016 miles from Cape Town. Kalomo, 93 miles north of the Falls, was reached May 29, 1905, since which time rapid progress has been made in laying track, the 281 miles from Kalomo to Broken Hill having been constructed in 346 days. On 99 days, however, no tracklaying was done, so that the rails were actually laid at the rate of more than a mile a day. The greatest mileage of track laid in any one day was 5¾ miles, which was laid between daylight and dark. From 3,000 to 5,000 natives and about 350 whites are constantly employed.

THE FLOATING DRYDOCK "DEWEY" reached the Philippine Islands on July 10, 1906, anchoring at Olongapo. This successfully completes a voyage of over 12,000 miles, a voyage of unusual character and of considerable risk. While the convoy met good weather, on the average, it had several mishaps and once or twice was in serious danger. In the crossing of the Atlantic the drydock broke away from its towing vessels and was recaptured only after a hundred-mile drift. In this incident the structure of the dock suffered some damage, which was repaired at the Canary Islands. In the Mediterranean the dock again got adrift for a short time. The passage through the Suez Canal involved some further difficulties, from the great width of the structure and the effect of side winds. The convoy left Solomon's Island, Chesapeake Bay, on Dec. 28, 1905; reached the Canaries on Feb. 23, 1906; sailed from the Canaries on March 18; passed Gibraltar March 25 and reached Malta on April 4; reached Port Said on April 18; sailed from Suez on May 3; passed Colombo June 5 and Sabong June 13, and reached Singapore June 21; left Singapore on June 28 and reached Olongapo, as noted, on July 10, making a trip of nearly 6½ months, including about one month of delay in port. A note in our issue of Jan. 4, 1906, p. 22, described the towing arrangements for the trip.

PLANS FOR VENTILATING THE NEW YORK SUBway, as presented in the report of Chief Engineer Rice (published in Engineering News, June 7, 1906), are now being carried out. By making openings at points where "pockets" of hot air have hitherto formed, the temperature in the subway has, according to Mr. Rice, already been lowered six to eight degrees as compared with that of last summer. The louvres and fans that were recommended in the report are now being installed.

In addition, experiments are being conducted with reference to cooling the air in the subway. Four wells have been sunk at the Brooklyn Bridge station, and ground water, which is obtained from these wells at a temperature of 50° F., is to be disposed in coils of iron pipe through which air will be blown. While no definite data have yet been obtained, there seems to be no doubt that, wherever ground water can be obtained in sufficient quantities, this method will prove highly efficient as well as comparatively economical.

AN EMPLOYER'S LIABILITY LAW has been enacted in France which follows the general lines of the law enacted in England a few years ago by making compensation compulsory to an injured workman whether there is any negligence or fault on the part of the employer or not. The underlying idea is that the cost of taking care of the maimed or killed in any industry and those dependent on them ought to be a charge upon the industry. The present law was enacted in 1898, but was made applicable to only a limited number of occupations. An amendment was enacted on April 12, 1906, extending the law to all commercial enterprises except agriculture. The general rates of compensation under the law are stated as follows by Vice-Consul Ingram, of Paris, in "Consular Reports" for July 11:

The annuity to the widow or widower, to be payable during life and to correspond to 20% of the annual wages of the deceased, and annuities to the children to vary between 15 and 40% of the annual wages, according to the number of children, payable up to the age of 16; the annuities to the children to reach even 60% in the event of their being left orphans. Should a widow or a widower remarry, the annuity granted ceases after payment of a lump sum representing three years' annuity; but the children's annuities continue to be paid. In the event of the deceased leaving no widow, widower or children, an annuity of 10 to 30% is allowed to other relatives.

As an example, a workman earning annually 1,500 francs ($285.50), killed by accident, leaves a widow aged 35 and three children under 10 years of age. An annuity of 300 francs ($58.50), or 20%, is allowed to the widow and an annuity of 525 francs ($101.32), or 35%, to the children.

In case of total disablement from work the victim of an accident receives a life annuity of 60% of his annual wages before the accident, and in case of partial disablement only he receives an annuity corresponding to one-half of the "loss of wage-earning power" caused by the accident. For example, the loss of a leg is generally estimated by the courts to be equivalent to 70% "loss of wage-earning power," so that after an accident of this kind a workman earning 1,500 francs ($289.50) annually would receive an annuity of 525 francs ($101.32), or 35%, which, supposing him to be 30 years of age, represents a capital of about 9,500 francs ($1,833.50).

For accidents causing temporary disablement from work the workman receives half the daily wage he was earning at the time of the accident until his complete recovery or until such time as the temporary disablement shall have become a permanent disablement, when the half wages are replaced by the compensation provided for total disablement. All medical and pharmaceutical expenses, as well as hospital and funeral expenses, to be borne by the employer.

THE VALUE AND CONDITION OF AGRICULTURAL lands needing drainage are being investigated by the irrigation and drainage investigations section of the U. S. Department of Agriculture, of which Mr. Elwood Mead, M. Am. Soc. C. E., is chief engineer, with Mr. C. G. Elliott, M. Am. Soc. C. E., as engineer in charge of the drainage studies. A number of inquiry blanks have been printed for the use of field agents. These cover: Swamp lands, lands in cultivated humid districts, lands subject to overflow, irrigated lands, meteorological data, current prices of material and labor, proposed drainage experiments and drainage surveys. Equally detailed schedules have been prepared for investigations of the duty of water for irrigation.

IN THE MANUFACTURE OF ELECTRICAL APPAratus, it is frequently necessary to impregnate the fibrous insulating covering of the wires with an insulating compound. By the Passburg vacuum impregnating process as developed by the J. P. Devine Co., of Buffalo, N. Y., the work of impregnation is done in a vacuum chamber and the coils to be treated are effectively freed of air and moisture before the compound is applied. The Electric Cable Co., of New York, has adopted the process for the impregnation of field coils, etc., with its "Voltax" insulating compound.

PERSONALS.

Mr. Bingley R. Fales has been appointed Assistant General Manager of the Detroit Edison Co.

Mr. John F. Stevens, Chief Engineer of the Panama Canal Commission, has been made a member of the Commission.

Mr. F. W. Smith has been appointed Assistant Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., at Cincinnati, Ohio.

Mr. C. F. Resseguie, General Superintendent of the first district of the St. Louis & San Francisco R. R., at Springfield, Ill., has resigned.

Mr. F. W. Bennett, of Albany, N. Y., has been appointed Superintendent of the barge canal operations at Sylvan Beach, N. Y., to succeed Mr. J. E. Burke.

Mr. J. H. Denton, formerly General Superintendent of the National Brake & Electric Co., has been made Manager of the new Air Brake Department of the Allis-Chalmers Co., of Milwaukee, Wis.

Mr. T. F. Rowlands, Trainmaster of the Salt Lake Division of the Southern Pacific Ry., has been promoted to Assistant Superintendent, at Sparks, Nev., succeeding Mr. J. F. Shaughnessy, resigned.

Mr. Harry Adkins, Assistant Engineer of the Illinois Central R. R., at Nashville, Tenn., has resigned to become Roadmaster of the Beaumont Division of the Colorado Southern, New Orleans & Pacific Ry.

Mr. W. T. Tyler, General Manager of the Louisiana & Arkansas Ry. has been appointed General Superintendent of the Atchison, Topeka & Santa Fe Ry., at Springfield, Ill., succeeding Mr. S. L. Rainey, assigned to other work.

Mr. J. M. Foster, of Lawrence, Mass., has been appointed Superintendent of the People's Cotton Mills, of Montgomery, Ala., to succeed Mr. M. E. Stevens, resigned, to become Superintendent of the Colu[illegible] Manufacturing Co.

Mr. Edward Hawes, Jr., of Florence S. C. [illegible] has been associated with Mr. Frederic Marshall, [illegible]ring and Contracting Engineer, of Abbeville, S. C. [illegible]cipal Assistant Engineer, has been elected City [illegible]neer of Orangeburg, S. C.

Mr. H. Van Atta, formerly Superintendent of [illegible] L. Mott Iron Works, announces that he is open[illegible] engagement as consulting mechanical engineer. [illegible] temporary address is care of the Ajax Decorating [illegible] 138th St. and Third Ave., New York City.

Mr. W. R. Sanborn, Engineer of Maintenance [illegible] Way of the Kankakee Division of the Chicago, [illegible]na & Southern R. R., has resigned to become Treas[illegible]r and General Manager of the Lehigh Stone Co., of [illegible]kakee, Ill., dealers in crushed, rubble, curb and flag [illegible]ne.

Mr. George H. Herrold, Division Engineer of [illegible] Wisconsin, Minnesota & Pacific Division of the Chica[illegible] Great Western Ry., at Red Wing, Minn., has been appointed Division Engineer of the Eastern Division of this road, with offices at 206 East Harrison St., Chicago, Ill.

Mr. W. J. Towne, Engineer of Permanent Improvements, Chicago & Northwestern Ry., has been appointed Engineer of Maintenance of Way for lines east of the Missouri River. Mr. A. A. Schenck has been appointed to a similar position for the lines west of the Missouri River.

Mr. John W. McKay, has been appointed acting Chief Engineer for the Department of Water Supply, Gas and Electricity, in Brooklyn, N. Y. The place has been vacant for several years and Mr. McKay will have entire charge of the water supply of Brooklyn, under the direction of Deputy Commissioner Cozier.

Mr. Frederick H. Mason, 612 Moffat Building, Detroit, Mich., Sales Agent for the Cochrane feed-water heaters, Scorge Cochrane purifying system and Cochrane separators, has also become representative for the State of Michigan, of Alphons Custodis Chimney Construction Co.

Obituary.

John Bernard Zimmele, a chemist connected with the Westinghouse Co., died at Pittsburg, Pa., July 9, of brain fever, caused by an automobile accident.

August Waldner, editor and publisher of our Swiss contemporary, "Schweizerische Bauzeitung," of which he was the founder, died on June 29, 1906, at Cannes, France, at the age of 62 years.

John W. Robinson, the founder of the Virginia Iron, Coal & Coke Co., died at his home in Graham Forge, Va., July 16, aged 67. He was prominently identified with the company until the time of his death.

Nehemiah Allen, a retired ship builder, died recently at his home in Brooklyn, N. Y. He was born at Yarmouth, Nova Scotia, Oct. 17, 1825, and was the first president of the Shipwrights' Association of New York.

Ira L. Pierce, of Wilmington, Del., General Superintendent of the mill of the Atlantic Dynamite Co., located near Ashland, Wis., was killed in the explosion of the neutralizing plant of that mill July 16. He was a graduate of Delaware College, and had also been instructor in chemistry at the same institution. He was about 32 years of age.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN INSTITUTE OF MINING ENGINEERS.
July 23 to Aug. 4. Joint meeting with the Iron and Steel Institute at London. Secy., R. W. Raymond, New York City.

CONCRETE BLOCK MACHINE MANUFACTURERS' ASSOCIATION.
Aug. 8, 9. Annual meeting at Detroit. Secy., S. L. Wiltse, Jackson, Mich.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 15 to 17. Annual convention at New Haven, Conn. Secy., Frank P. Foster, Corning, N. Y.

LEAGUE OF AMERICAN MUNICIPALITIES.
Sept. 26 to 28. Annual convention at Chicago, Ill. Secy., Jno. MacVicar, Des Moines, Ia.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.—The eleventh annual convention of the association will be held at New Haven, Conn., Aug. 15 to 17. Among the papers to be presented are the following: "History of the Fire and Police Telegraph," Adam Bosch; "Details of Certain Auxiliaries of Fire Alarm Apparatus," J. B. Yeakle; "Advisability of Protecting Municipal Electricians by the Civil Service Laws," Jerry Murphy; "Comparison of Underground and Overhead Wiring, and of the Relative Values of Single, Rubber Covered Wire and Lead Incased Cable for Underground Construction," W. H. Thompson; "Conditions Surrounding the Inspection of Wires in the Southwest (with special reference to the advisability of one inspector completing each inspection instead of several inspectors each doing part of it)," Clarence R. George.

LEADING ART
Reinforced C
Recent Exte
A Universal
(illustrat
Variations
(illustrat
Piping in S
A New For
Reconstruct
(illustra
Methods of
Steam Mete
Reinforced
Fads and
Two Engli
Concrete H
The Use o
trated)

REINFORCED

A good
bridge cons
tion on this
built at Pla
Pacific R. I
the mainlan
is 205 ft. 8
of 146 ft.,
a ribbed ar
piles. The
thick, and
beams each

carry a
lamp pos
was desi
Engineer

RECENT

The c
compres
rapidly
began r
and for
merely
drill, so
urally h
continu

Now,
air hav
not con
pressed
calkers,
related
large n
extensi
differen